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# Design and Manufacturing of Portable Harvester

Er. Akshay Ghorpade[1], Er. Pranav Dake[2]
*Department of Mechanical Engineering, KITCOEK Kolhapur (Shivaji University)*

***Abstract- The project is intended to help small-scale grain growers to meet an increased demand for diverse, locally grown grains by designing a small scale harvester. To refine our prototype and final design, we worked closely with a three person review panel, made up of grain farmers and industrial designers. With this prototype, we hope to provide farmers nationwide with a way to harvest grains on small plots of land in cities and along the periphery of urban areas. Our primary intension was to reduce down the capacity as well as the cost of the machine. This was thought so as to make the machine affordable to the Indian farmers. According to the survey, the per capita land owned by Indian farmer is tiny so this makes it obvious that the existing machines are not laconic. The capacity was so reduced that it would cater the needs on the fields. The harvester design is kept simpler so that any discontinuity in working would not affect the work. The machine being small in size is very easy to transport.***
***Keywords- Small scale grain growers, Per capita land, Capacity, Cost, Laconic***

## I. INTRODUCTION

As India has large agricultural sector, the main crops in lower rainfall regions are Jowar, Hybrid and Bajra. The machines are not available to cut upper part of these crops and harvest them simultaneously. Also the latest technologies involved in design and manufacturing have made them more costly to buy for common farmer. These systems available require manual cutting. This conventional method requires high labour efforts and cost. The Harvesters available now are large in size and capacity which is not feasible as far as Indian scenario is concerned. So by taking this problem into account we are designing and manufacturing a harvester fulfilling all the basic needs as expected from same but at lower cost and capacity. It may be considered as automation in the agricultural practices. Our main concern is to build such a system which would harvest the crop and enable the farmer to increase productivity. It also reduces the time required for total process.

## II. PROBLEM DEFINITION

It's a machine which harvests upper part (Kanis) of crops like Jowar and Bajra. Now in conventional methods the crop is cut first manually and stored, then it is harvested in harvester. So we are designing and manufacturing a harvester doing the work as explained above. The machine designed by us can harvest the crop in single machine itself. The cost of present harvesters is not affordable for common farmers. The machines for such applications are not available as single unit.

## III. OBJECTIVES

*A.* To Design and manufacture a harvester in reduced size and capacity.
*B.* To come up with a harvester which would be economic to farmers.
*C.* To make the harvester portable which can be moved to places with fewer efforts.
*D.* To make the harvester multipurpose so as to use it for other than above crops.
*E.* To make the design simpler to reduce the maintenance cost.

## IV. METHODOLOGY

### *A. Data Collection*

The design of the harvester starts from the initial data collection. The initial data includes information about crop, in this height of crop, the period of growth, etc. Also the data about working of present harvesters, the driving mechanism given to them, the power required for them is collected. The data collection is done by market survey and doing visit to actual field.

### *B. Layout Finalization*

The final layout of machine is done according to the data.

### *C. Detailed Design*

The next part of process is to design various parts of system in detail which are-

1) Crusher
2) Sieve
3) Blower
4) Power train

The design consists of all information about the parts. The design of conveying system is based on design of above parts.

*D. Evaluation and Drafting*

Once the components are designed, they are tested for their strength on the analysis software. Then they are assembled and the mechanisms are observed for their proper working and non-interrupted motion. The drafting and production drawing as per the codes and conduct of the sponsor are taken into account.

*E. Assembly*

The parts are designed and evaluated for assembly. The harvester is then assembled for final appearance.

*F. On Field Trials*

The combined harvester is taken to actual field conditions for testing. Testing will be carried out at start of February as it is the season for crops like Jowar, Bajra. All the components are tested for their proper functioning. If any problem arises, corrective action will be taken and the trial will again be taken to confirm proper functioning of all parts.

*G. Expenditure*

The key of this project is to be able to provide robust and workable design to the Indian farmers so that the project can be subsequently taken up for many more such machines in future. The estimated cost of this project is around Rs. 15000 to 18000.

## V. INITIAL CONCEPT OF THE PROPOSED EQUIPMENT

It is mainly agriculture based project. It includes harvesting the cut crop. The work consists of designing and manufacturing of following components and their assembly-

*A. Thresher*

It is the most important part of harvester. It is made up of number of studs on its periphery. They are so arranged that it keeps a constant gap in between two adjacent bolts and in between two adjacent rows as well. In some threshers there are some cutting blades provided in order to smash down the Kanis into pieces so that it would help to reduce down the efforts to crush. The studs are fixed on a metal plate of certain width in a line. Such numbers of strips are attached to two metal rings at both ends to make a closed ring type structure. A net of metal rods is placed at bottom side of crusher ring which is curved. This net is having a gap in network so that it allows the grains to fall down through it. The casing is provided on this crusher with suitable clearance provided in between them, such that the Kanis gets trapped in this gap and gets shattered. The bolts strike the Kanis at high speed in order to separate grains off it. The casing is provided with an opening for inserting Kanis for threshing or crushing. The casing is bolted to frame.

*B. Blowers*

There are two blowers provided on machine. The work of picking up the husk to blow away is divided into two parts by these two blowers. These blowers are driven by the same shaft. This shaft also drives the crusher as well (being a common shaft running through the length). Blower consists of 4 closed structured metal plates. This structure helps to create negative pressure inside the blower which allows the husk to be lifted up. The duty of one of the two blowers is to lift the husk form coarse sieve and the rest has to lift the husk from fine sieve. As the grains come out of crushing chamber they are allowed to fall on a sieve. The 1st blower then lifts the husk at this point. Most of the husk is been lifted by this blower. After this the grain comes to fine sieve where the remaining husk is been lifted by second blower.

*C. Sieve*

The sieve serves the function of separating the husk from grains. There are two sieves provided for this. The two sieves are so attached to get single unit. The first sieve is coarse one. It separates the husk at maximum possible. The grain then gets over second sieve so that the remaining husk is separated. The two blowers are so placed over the sieve that they suck the husk from sieve. 1st blower is placed at the start of coarse sieve and the second blower at fine sieve at the end. The grains after passing through these two sieves come out of fine sieve and are now ready to store.

*D. Support Frame*

All components are rested on the support frame. It is a rectangular shaped structure where there are four legs on which it rests. Another frame is created on a pair of legs for mounting of shaft 2 (which is meant to drive the sieve). Main frame is split into two parts for mounting of blower and crusher. The support frame also provides three members for supporting the sieve so that it moves in horizontal constrained plane only.

*E. Power train*

The main shaft is given power from external source. The shaft gives power to crusher, Blower and sieve. A direct drive through belt is provided for main shaft. The sieve is given power through quarter turn belt drive. The main shaft rotated at 750rpm whereas the rpm given to sieve is reduced to half through pulleys. It is 375rpm.

| Sr. No. | Model Specification | Power (HP) | Price (Rs.) | Capacity(Kg/hr) |
|---|---|---|---|---|
| 1 | Double Wheel Triple Fan 1  | 25 | 1,44,000 | 550-600 |
| 2 | Double Wheel Triple Fan 2  | 20 | 1,39,500 | 400-450 |
| 3 | Double Wheel Triple Fan 3  | 15 | 1,36,500 | 300-350 |

| | | | | |
|---|---|---|---|---|
| 4 | Single Wheel Double Fan  | 5 | 58,000 | 150-200 |
| 5 | Single Wheel Double Fan *(Our Machine)*  | 2 | 18,000 | 50-100 |

COMPARISON WITH AVAILABLE MACHINE

## VI. DESIGN CALCULATIONS

*A. Power Calculation*

*The power required for harvester is,*

*Power can be given as,*

$P = 2\pi NT/60$

*Where,*

$N$ = *Speed of rotating shaft* = $720 rpm$

$T$ = *Torque acting on shaft*

*Torque can be calculated as follows,*

*Consider* 100 *N crushing force acted upon Kanis by thresher ring.*

$F = 100\ N$

*Torque,* $T = F\ x\ R$

*Where,* $R$ = *radius of thresher ring* = $0.150\ m$

$T = 100\ x\ 0.150$

$T = 15\ Nm$

*Therefore, required power is given as,*

$P = (2\ x\ \pi\ x\ 720\ x 15)/60$

$= 1130.9733\ W$

$P = 1.13 KW$

The power to be required is 1.13KW i.e. 1.51 HP

Motor selected for application is of 2 HP.

*B. Selection of Belt*

*1)* For drive pulley

*Motor Speed* = $1440\ rpm$

*Power to be transmitted* = $2HP$ = $1.492\ KW$

*Shaft Speed* = $720\ rpm$

*Centre Distance* $(C)$ = $510\ mm$

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$Selection\ of\ V\ belt\ from\ manufacture\ catalogue\ -$

$Steps: -$

1) $Correction\ Factor\ (\ Fa\ )\ -$

$It\ depends\ on\ type\ of\ driving\ unit, type\ of\ driven\ machine\ and\ the\ operational\ hours\ per\ day.$

$For\ normal\ torque, squirrel\ cage\ , motor\ and\ for\ heavy\ duty\ machine\ for\ 8\ hours\ of\ operation\ per\ day,$

$Correction\ factor\ (Fa)\ =\ 1.2$ ……… $[Table\ 13.15, Page\ No.525, V.B.Bhandari]$

2) $Calculation\ of\ design\ power\ -$

$Design\ power\ =\ Fa(Transmitted\ power)$

$=\ 1.2\ x 1.492$

$Design\ power\ =\ 1.7404\ KW$

3) $Type\ of\ cross - section\ of\ belt\ -$

$By\ plotting\ design\ power\ as\ X\ co - ordinate\ and\ input\ speed\ as\ Y\ co - ordinate, cross\ section\ of\ belt\ is\ decided\ by\ this\ point$

$Cross - section\ of\ Belt\ is\ B$ … $[Table\ 13.24, Page\ No.523, V.B.Bhandari]$

4) $Calculation\ of\ pitch\ diameters\ of\ pulleys$

$The\ pitch\ diameter\ of\ bigger\ pulley\ is\ given\ as,$

$D\ =\ d\ (Speed\ of\ smaller\ pulley)/(Speed\ of\ bigger\ pulley)$

$D\ =\ d\ (input\ speed)/(output\ speed)$

$D\ =\ d\ (N1/N2)$

$Let, d\ =\ 50\ mm$

$D\ =\ 50\ x\ (1440/720)$

$D\ =\ 100\ mm$

$Hence, D\ =\ 100\ mm\ and\ d\ =\ 50\ mm$ … $[Table\ 13.13, Page\ No.524, V.B.Bhandari]$

5) $Calculation\ of\ pitch\ length$

$L\ =\ 2\,C\ +\ \pi x(\,D + d)/\,2\ +\ (D - d)2/4C$

$L\ =\ 2x480\ +\ \pi\ (100 + 50)/2\ +\ (100 - 50)2\ /4x480$

$L\ =\ 1196.844\ mm$

6) $Corrected\ pitch\ length$

$L\ =\ 1210\ mm$ … $[Table\ 13.14, Page\ No.524, V.B.Bhandari]$

7) $Corrected\ centre\ distance$

$L\ =\ 2xc\ +\ \pi(D + d)\ /2\ +\ (D - d)2/4C$

$1210\ =\ 2C + \pi\ (100 + 50)/2\ +\ 502/4xC$

$C2\ - 974.386\ C\ + 625\ =\ 0$

$Hence, C\ =\ 510\ mm$

8) $Correction\ factor\ (Fc)\ for\ belt\ pitch\ length$

$On\ basis\ of\ cross\ section\ type\ and\ pitch\ length,$

$Correction\ factor\ (Fc)\ =\ 0.87$ … $[Table\ 13.21, Page\ No.534, V.B.Bhandari]$

9) $Arc\ of\ contact\ for\ smaller\ pulley$

$\alpha s\ =\ 180 - 2\ Sin\ - 1\ (D - d\ )\ /2xC$

$\alpha s\ =\ 180 - 2\ Sin\ - 1\ (100 - 50)\ /2x510$

$\alpha s\ =\ 174.380$

$Correction\ factor\ (Fd)\ for\ arc\ of\ contact$

$Fd\ =\ 0.99$ … $[Table\ 13.22, Page\ No.534, V.B.Bhandari]$

10) $Power\ ratings\ for\ V\ belt\ (Pr)$

$It\ depends\ upon\ speed\ of\ faster\ shaft, pitch\ diameter\ of\ smaller\ pulley\ and\ the\ speed\ ratio.$

$Pr\ =\ 1.12\ +\ 0.19$ … $[Table\ 13.17, Page\ No.528, V.B.Bhandari]$

$Pr\ =\ 1.31$

$Selection\ of\ Belt\ for\ Quarter\ turn\ drive\ -$

$Input\ Speed\ =\ 720\ rpm$

$Power\ to\ be\ transmitted\ =\ 2HP\ =\ 1.492\ KW$

$Output\ Speed\ =\ 360\ rpm$

$Centre\ Distance\ (C)\ =\ 350\ mm$

$Selection\ of\ V\ belt\ from\ manufacture\ catalogue$

$Steps: -$

1) $Correction\ Factor\ (Fa)\ -$

$It\ depends\ on\ type\ of\ driving\ unit, type\ of\ driven\ machine\ and\ the\ operational\ hours\ per\ day.$

$For\ normal\ torque, squirrel\ cage, motor\ and\ for\ heavy\ duty\ machine\ for\ 8\ hours\ of\ operation\ per\ day,$

$Correction\ factor\ (Fa)\ =\ 1.2$ $\ldots [Table\ 13.15, Page\ No.\ 525, V.B.Bhandari]$

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$Design\ power\ =\ Fa\ (Transmitted\ power)$

$=\ 1.2\ x 1.492$

$Design\ power\ =\ 1.7404\ KW$

3) $Type\ of\ cross\ section\ of\ belt$

$By\ plotting\ design\ power\ as\ X\ co-ordinate\ and\ input\ speed\ as\ Y\ co$

$-ordinate, cross\ section\ of\ belt\ is\ decided\ by\ this\ point$

$Cross\ section\ of\ Belt\ is\ B$ $\ldots [Table\ 13.24, Page\ No.\ 523, V.B.Bhandari]$

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$D\ =\ d\ (Speed\ of\ smaller\ pulley)/(Speed\ of\ bigger\ pulley)$

$D\ =\ d\ (input\ speed)/(output\ speed)$

$D\ =\ d\ (N1/N2)$

$Let, d\ =\ 50\ mm$

$D\ =\ 50\ x\ (1440/720)$

$D\ =\ 100\ mm$

$Hence, D\ =\ 100\ mm\ and\ d\ =\ 50\ mm$ $\ldots [Table\ 13.13, Page\ No.\ 524, V.B.Bhandari]$

5) $Calculation\ of\ pitch\ length$

$L\ =\ 2\ C\ +\ \pi x(\ D+d)/\ 2\ +\ (D-d)2/4C$

$L\ =\ 2x480\ +\ \pi\ (100+50)/2\ +\ (100-50)2\ /4x480$

$L\ =\ 1196.844\ mm$

6) $Corrected\ pitch\ length$

$L\ =\ 1210\ mm$ $\ldots [Table\ 13.14, Page\ No.\ 524, V.B.Bhandari]$

7) $Corrected\ centre\ distance$

$L\ =\ 2xc\ +\ \pi(D+d)\ /2\ +\ (D-d)2/4C$

$1210\ =\ 2C\ +\ \pi\ (100+50)/2\ +\ 502/4xC$

$C2\ -974.386\ C\ +625\ =\ 0$

$Hence, C\ =\ 510\ mm$

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$\alpha s\ =\ 180 - 2\ Sin\ -1\ (D-d\ )\ /2xC$

$\alpha s\ =\ 180 - 2\ Sin\ -1\ (100-50)\ /2x510$

$\alpha s\ =\ 174.380$

$Correction\ factor\ (Fd)\ for\ arc\ of\ contact$

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$It\ depends\ upon\ speed\ of\ faster\ shaft, pitch\ diameter\ of\ smaller\ pulley\ and\ the\ speed\ ratio.$

$Pr = 1.12 + 0.19$ $\quad \ldots [Table\ 13.17, Page\ No. 528, V.B. Bhandari]$

$Pr = 1.31$

$Selection\ of\ Belt\ for\ Quarter\ turn\ drive -$

$Input\ Speed = 720\ rpm$

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$Selection\ of\ V\ belt\ from\ manufacture\ catalogue$

$Steps: -$

1) $Correction\ Factor\ (Fa) -$

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$Design\ power = Fa\ (Transmitted\ power)$

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$Design\ power = 1.7404\ KW$

3) $Type\ of\ cross\ section\ of\ belt$

$By\ plotting\ design\ power\ as\ X\ co - ordinate\ and\ input\ speed\ as\ Y\ co$

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$Cross\ section\ of\ Belt\ is\ B$ $\quad \ldots [Table\ 13.24, Page\ No. 523, V.B. Bhandari]$

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$D = d\ (Speed\ of\ smaller\ pulley)/(Speed\ of\ bigger\ pulley)$

$D = d\ (input\ speed)/(output\ speed)$

$D = d\ (N1/N2)$

$Let\ d = 80mm$

$D = 80x(1600/800)$

$D = 160\ mm$

$Hence, D = 160\ mm\ and\ d = 80\ mm$ $\quad \ldots [Table\ 13.13, Page\ No. 524, V.B. Bhandari]$

5) $Calculation\ of\ pitch\ length -$

$L = 2\ C + \pi x(\ D + d)/\ 2 + (D - d)2/4C$

$L = 2x350 + \pi\ (160 + 80)/2 + (160 - 80)2\ /4x350$

$L = 1081.56\ mm$

6) $Corrected\ pitch\ length -$

$L = 1100\ mm$ $\quad \ldots [Table\ 13.14, Page\ No. 524, V.B. Bhandari]$

7) $Corrected\ centre\ distance -$

$L = 2xc + \pi\ (D + d)\ /2 + (D - d)2/4C$

$1100 = 2C + \pi\ (160 + 80)/2 + 802/4xC$

$C2 - 361.505\ C + 800 = 0$

$Hence, C = 360\ mm$

8) $Correction\ factor\ (Fc)\ for\ belt\ pitch\ length -$

$On\ basis\ of\ cross\ section\ type\ and\ pitch\ length,$

$Correction\ factor\ (Fc) = 0.85$ $\quad \ldots [Table\ 13.21, Page\ No. 534, V.B. Bhandari]$

9) $Arc\ of\ contact\ for\ smaller\ pulley -$

$\alpha s = 180 - 2\ Sin\ - 1\ (D - d\ )\ /2xC$

$\alpha s = 180 - 2\ Sin\ - 1\ (160 - 80)\ /2x350$

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$\alpha s = 169.220$

$Correction\ factor\ (Fd)\ for\ arc\ of\ contact\ -$

$Fd = 0.97$ ... [$Table$ 13.22, $Page\ No.$ 534, $V.B.Bhandari$]

10) $Power\ ratings\ for\ V\ belt\ (Pr)\ -$

$It\ depends\ upon\ speed\ of\ faster\ shaft, pitch\ diameter\ of\ smaller\ pulley\ and\ the\ speed\ ratio.$

$Pr = 0.66 + 0.10$ ... [$Table$ 13.17, $Page\ No.$ 528, $V.B.Bhandari$]

$Pr = 0.76$

*C. Design of Sieve Shaft*

*1) Belt tension for design of shaft –*

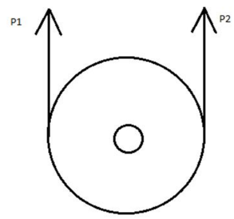


*Figure 1. Reaction on shaft*

*Load on shaft due to shaking of sieve is considered 50N in horizontal direction.*

*Pitch diameter of pulley = 160mm*

*So, R= 80mm*

*Angle of wrap for pulley = θ =180o*

*Coefficient of Friction = μ= 0.24*

*Calculation of torque on shaft –*

*P = 2πNT/60 =1.497KW = 1.497x103W*

*So, N = 360 rpm*

*T = 39.70 x103N.mm*

*Calculation of load on shaft due to pulley –*

*By using relation,*

*T1/T2 = eμθ = e0.24xπ = 2.125*

*So, T1 = 2.125T2* ..................(1)

*The torque supplied to shaft is also given as,*

*(T1-T2)xR = Mt*

*(T1-T2)×80 = 39.70×103*

*So, (T1-T2) = 496.25* ....................(2)

*From equation (1) and (2), solving,*

*T2 = 441.11 N*

*T1 = 937.36 N*

*Load due to Pulley on shaft = T1+T2+Weight of pulley*

*= 937.36+441.11+20*

*= 1398.47N in vertical upward direction*

*(2)The loads acting on shaft are in both directions i.e. in calculation of bending moments –*

*a) In vertical direction –*

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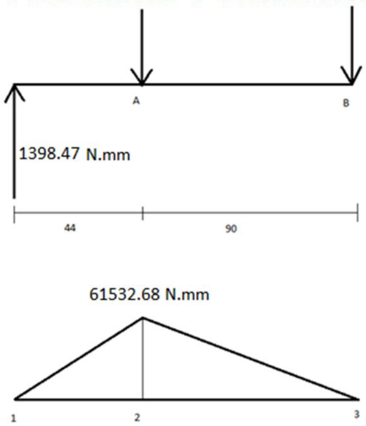


Figure 2. Bending moments on shaft

$Calculation\ of\ reactions,$
$RAv + RBv = 1398.47N$ ........................ (1)
$Taking\ moment\ about\ point\ B,$
$1398.47x44 = -90xRBY$
$So, \quad RBY = -683.69N$
$From\ equation\ (1),$
$RAV = 2082.16N$
$B.M.\ Calculation -$
$B.M.at\ 1 = 0$
$B.M.at\ 2 = 1398.47x44$
$= 61532.68N.mm$
$B.M.at\ 3 = 0$
$Maximum\ bending\ moment\ in\ vertical\ direction,$
$Mb\ at\ A = 61532.68N.mm$
$b)\ In\ horizontal\ direction\ -$

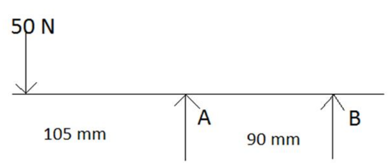


Figure 3. Bending moment on shaft

$Calculations\ of\ reactions\ -$
$RAh + RBh = 50\ N$
$Taking\ moment\ @\ A,$
$-50x105 = 90xRB$
$RBh = -58.33\ N$
$RAh = 108.33\ N$
*Bending Moment calculation-*

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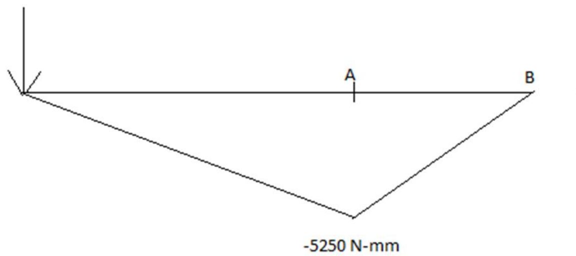


Figure 4. Bending moment on shaft

$B.M.@1 = 0$

$B.M.@2 = -5250\ N-mm$

$B.M.@3 = 0$

*Maximum bending moment in horizontal direction is at A, which is given as*

$MbH\ at\ A = -5250\ N-mm$

$By\ using\ relation\ Mb = \sqrt{Mb\ v2 + Mb\ h2}$

*Total bending moment is calculated,*

$Mb = \sqrt{61532.68^2 + (-5250)^2}$

$Mb = 61756.24\ N-mm$

$Torsional\ Moment\ (Mt) -$

*It is torque acting on the shaft which is calculated as,*

$P = (2x\pi xNxT) / 60$

$P = 1.497\ KW$

$N = 360\ rpm$

$Therefore\ T = 39.70x103\ N-mm$

$Mt = 39.70x103\ N-mm$

3) *Design of shaft* $-$

*The design of shaft is based upon equivalent torsional moment method*

*The value of shock and fatigue factors are given on the basis of application of load,*

*For gradually applied load,*

$Kb = shock\ factor = 1.5$

$Kt = fatigue\ factor = 1$ ……… [*Table* 9.2, *Page No.* 334, *V.B.Bhandari*]

*Material selection* $-$

*The material selected for shaft is Mild steel with grade* 30C8

*Properties*: $-$

$Ultimate\ tensile\ strength = Sut = 500\ N/mm2$

$Yield\ strength = Syt = 400\ N/mm2$ … [*Table* 2.2, *Page No.* 31, *V.B.Bhandari*]

*The permissible shear stress can be given as*

$\tau max = (0.5Sut) / F.S.$

$Factor\ of\ safety = 2$

$\tau max = (0.5x500)/2$

$\tau max = 125\ N/mm2$

*The shaft diameter is calculated by using equivalent torsional moment method,*

*The permissible shear stress can be given as,*

$\tau max = 16x\sqrt{(Kb\ X\ Mb)^2 + (Kt\ X\ Mt)^2} / \pi xd3$

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*Putting all known values in above equation*

$$125 = (16x\sqrt{(1.5\,X\,61756.24)^2 + (39.70\,X\,10\,X\,10\,X\,10)^2}\,)/\,\pi\,xd3$$

$$d = 15.56\,mm \approx 20\,mm$$

$$d = 20\,mm \qquad -----\ diameter\ of\ shaft$$

*D. Bearing selection for Sieve shaft –*

*The support reaction are given as follow*

*At point A (bearing 1) –*

$$RAV = 2082.16\,N$$

$$RAH = 108.33\,N$$

*At point B, (bearing 2) –*

$$RBV = -686.69\,N$$

$$RBH = -58.33\,N$$

$$RA = \sqrt{Rav^2 + Rah^2}$$

$$= \sqrt{2082.16^2 + 108.33^2}$$

$$RA = 2084.97\,N$$

$$RB = \sqrt{Rbv^2 + Rbh^2}$$

$$= \sqrt{(-686.69)^2 + (-58.33)^2}$$

$$RB = 689.16\,N$$

*Radial forces on bearings are,*

$$Fr1 = RA = 2084.97\,N$$

$$Fr2 = RB = 689.16\,N$$

*There is no any axial thrust is acting on bearings,*

$$Fa1 = Fa2 = 0$$

*Dynamic load calculations*

$$P1 = Fr1 = 2084.97\,N$$

$$P2 = Fr2 = 689.16\,N$$

*Calculation of dynamic load capacity: –*

*The life of bearings selected is on basis of machine used for eight hours*

$$L10h = 12000\,hr \qquad \ldots[Table\ 15.2, Page\ No.\ 573, V.B.Bhandari]$$

$$Speed\ of\ shaft = 360\,rpm$$

*Life of bearing in million f revolution is given as,*

$$L10 = (60xnx\,L10h)\,/106$$

$$= (60x360x12000)/\,106$$

$$L10 = 259.2\ million\ revolution\,.$$

$$Load\ factor = 2 \qquad \ldots[Table\ 15.3, Page\ No.\ 573, V.B.Bhandari]$$

*Dynamic load capacity for bearing 1 –*

$$C1 = P1x(L10)1/3x(load\ factor)$$

$$= 2084.97x259.21/3x2$$

$$C1 = 26587.33\,N$$

*Dynamic load capacity for bearing 2 –*

$$C2 = P2x(L10)1/3x(load\ factor)$$

$$= 689.16x259.21/3x2$$

$$C2 = 8788.10\,N$$

Table 1. Bearing Specification -

| Parameter | Bearing 1 (16007) | Bearing 2 (6404) | Bearing 3 (6407) |
|---|---|---|---|

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| | | | |
|---|---|---|---|
| Inner diameter | 35mm | 40mm | 35mm |
| Outer diameter | 62mm | 68mm | 100mm |
| Width | 9mm | 9mm | 25mm |
| Dynamic load carrying capacity | 12400N | 13300N | 55300N |
| Static load carrying capacity | 6950N | 7800N | 31000N |

[Table 15.5, Page No. 575, V. B. Bhandari]

*E. Design Of Flywheel –*

*Type – Solid disk flywheel*

*The material selected for flywheel is carbon steel which has properties as follows,*

$Density\ =\ \varrho\ =\ 7800\ Kg/m3$ $\quad \ldots [Table\ 21.1, Page\ No.\ 751, V.B.Bhandari]$

*The coefficient of fluctuation of energy for flywheel is taken as,*

$Ce\ =\ 0.066$ $\quad \ldots [Table\ 21.3, Page\ No.\ 753, V.B.Bhandari]$

*The coefficient of fluctuation of energy is also given as,*

$Ce\ =\ (Maximum\ fluctuation\ energy)\ /\ (work\ done\ per\ cycle)$

$Ce\ =\ (U0)/\ (work\ done\ per\ cycle)$

*Work done per cycle is calculated as below*

$W.D/\ cycle\ =\ 4x\pi xTm$

$Where, Tm\ =\ torque\ on\ shaft$

$Tm\ =\ 19.85\ N-m$

$W.D/\ cycle\ =\ 4x\ \pi\ x\ 19.85$

$W.D/\ cycle\ =\ 249.44\ N-m$

*Therefore,*

$0.066\ =\ (U0)/\ 249.44$

$U0\ =\ 16.463\ N-m$

$Maximum\ fluctuation\ energy\ =\ U0\ =\ 16.463\ N-m$

*The moment of inertia of flywheel disk is given by equation*

$I\ =\ (U0)/(\omega 2\ xCs)$

$Where, \omega\ =\ angular\ speed\ of\ shaft$

$\omega\ =\ (2x\pi xN)/60$

$=\ (2x3.14x720)/60$

$=\ 75.39\ rad/sec$

$Cs\ =\ coefficient\ of\ fluctuation\ of\ speed$

$Cs\ =\ 0.025$ $\quad \ldots [Table\ 21.2, Page\ No.\ 752, V.B.Bhandari]$

$I\ =\ (16.463)\ /\ (75.392\ x\ 0.025)$

$I\ =\ 0.1158\ Kg.m2$

*The moment of inertia is also given as ,*

$I\ =\ (\pi x\varrho xtxR4)/2$

$Where, \varrho =\ Density\ of\ flywheel\ material$

$=\ 7800\ Kg/m3$

$t\ =\ thickness\ of\ disk\ =\ 0.02\ m$

$R\ =\ radius\ of\ disk\ (m)$

$0.1158\ =\ (\pi x7800x0.02x\ R4)/\ 2$

$R\ =\ 0.150\ m\ =\ 150\ mm$

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*The mass of flywheel is calculated by relation,*

$I = (mxR2)/2$

$0.1158 = m\,x0.152/2$

$m = 14.07\,Kg \approx 15\,Kg$

*Flywheel parameter,*

$Outer\ diameter = 300\,mm$

$Inner\ diameter = 40\,mm$

$Thickness = 20mm$

*Design Of Keys –*

*The keys to be designed are of square and flat keys.*

*The material selected for keys is Mild steel with grade 30C8. Which has yield strength is,*

$Syt = 380N/mm2$ ... [$Table\ 2.2, Page\ No.\ 31, V.B.Bhandari$]

*Steps: –*

*Calculation of permissible compressive and shear stresses*

$Syc = Syt = 380N/mm2$

$Бc = (Syc)/F.S.$

$= 380/3$

$= 126.67\,N/mm2$

*According to maximum shear stress theory of failure*

$Ssy = 0.5xSyt = 0.5x380$

$= 190\,N/mm2$

$Ţ = (Ssy)/(F.S.)$

$= 190/3$

$Ţ = 63.33\,N/mm2$

*Key 1:*

*Torque transmitted by shaft*

$T = 19.85\,x103\,N - mm$

*Key dimension ,*

$b = h = d/4 = 35/4$

$b = h = d = 8.75 \approx 8\,mm$

$b = width\ of\ key$

$h = height\ of\ key$

$Length\ of\ key = 80mm$

*Check for shear,*

$Ţ = (2xMt)\ /\ (dxbxl)$

$= (2x19.85x103)\ /\ (35x8x80)$

$Ţ = 1.79\,N/mm2 < 63.33\,N/mm2$

*Design is safe Check for crushing*

$Бc = (4xMt)/(dxhxl)$

$= (4x19.85x103)/(35x8x80)$

$Бc = 3.54\,N/mm2 < 126.67\,N/mm2$

*Design is safe*

*Key 2:*

*Torque transmitted by shaft*

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$T = 39.70\ x103\ N - mm$

*Key dimension* ,

$b = h = d/4 = 25/4$

$= 6.25 \approx 6\ mm$

$b =$ *width of key*

$h =$ *height of key*

*Length of key* $= 60mm$

*Check for shear* –

Ƭ $= (2xMt)/(dxbxl)$

$= (2x39.70x103)\ /\ (25x6x60)$

Ƭ $= 8.81\ N/mm2 \quad < 63.33\ N/mm2$

*Design is safe*

*Check for crushing* –

Бc $= (4xMt)\ /\ (dxhxl)$

$= (4x39.70x103)\ /\ (25x6x60)$

Бc $= 17.64\ N/mm2 \quad < 126.67\ N/mm2$

*Design is safe*

*F. Design of Main Shaft* –

*The shaft is subjected to both vertical and horizontal loads*

*Calculation of bending moment* –

1) *In vertical direction*-

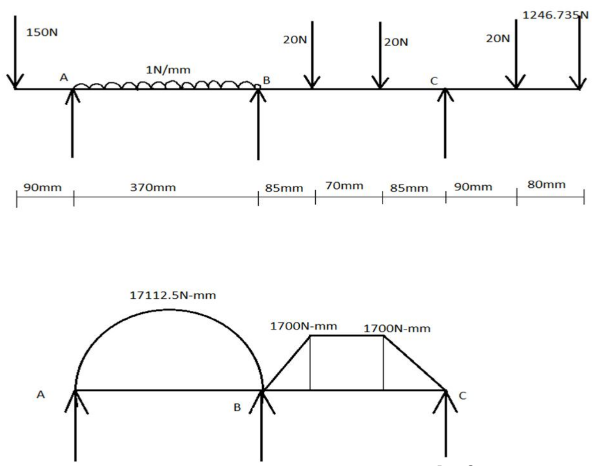


*Figure 5. Moment on main shaft*

*Span moment for AB*,

*Max B.M.* $= (Wxl2)/8$

$= (1x3702)/\ 8$

$= 17112.5\ N - mm$

*For BC*,

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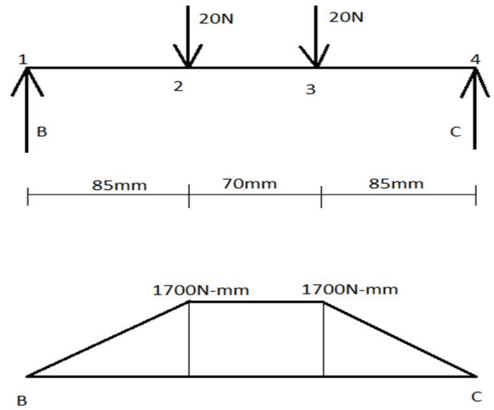


Figure 6. Reaction on main shaft

$Reaction\ calculations -$

$RB + RC = 40\,N$

$Taking\ moment\ about\ point\ C$

$RB\,x240 - 20x1.55 - 20x85 = 0$

$240RB - 3100 - 1700 = 0$

$RB = 20N$

$RA = 20N$

$Bending\ moment\ calculation -$

$B.M.at\ point\ 1 = 0$

$B.M.at\ point\ 2 = 1700\ N - mm$

$B.M.at\ point\ 3 = 1700N - mm$

$B.M.at\ point\ 4 = 0$

$Support\ moment\ calculation -$

$Apply\ three\ moment\ theorem\ (TMT)\ on\ span\ AB + BC$ $\quad \ldots (SOM - Ramamrutam)$

$MAxl1 + 2xMB(l1 + l2) + MC\ x\ l2 = (6xa1xx\bar{1})/\ l1 + (6xa2\ x\ x\bar{2})\ /\ l2$

$Where,$

$+MA = 150x90 = 13500\ N - mm$

$l1 = 370mm$

$MB = ?$

$l2 = 240\ mm$

$MC = 213744.95\ mm$

$a1 = 2x370x17112.5/3$

$= 4.22x106\ mm2$

$x\bar{1} = 185\ mm$

$a2 = (1x85x1700/2) + (1700x70) + (1x1700x85/2)$

$a2 = 263500\ mm2$

$x\bar{2} = (2x85/3) + 35 + (1x85/3)$

$= 116.67\ mm$

$Putting\ all\ values\ in\ above\ equation, we\ get,$

$(13500x370) + (2xMB\ x610) + (213744.95x240)$

$= (6x4.22x106\ x185)/370 + (6x263500x116.67)/240$

$2.29x106 + 1220\ MB + 51.3\ x106 = 12.66x106 + 768563.63$

$= 13.43\ x106\ N - mm$

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*MB = -32018.033 N-mm*

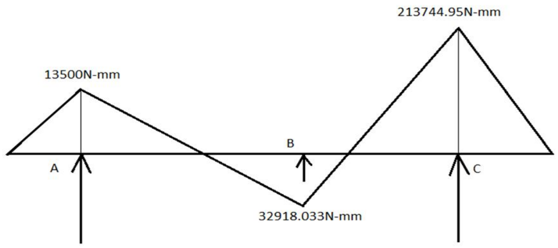


*Figure 7. Moments at supports*

*Reaction calculation* $-$

$$RA + RB + RC = 1826.735\, N$$

*Taking moment about point B for span DAB*,

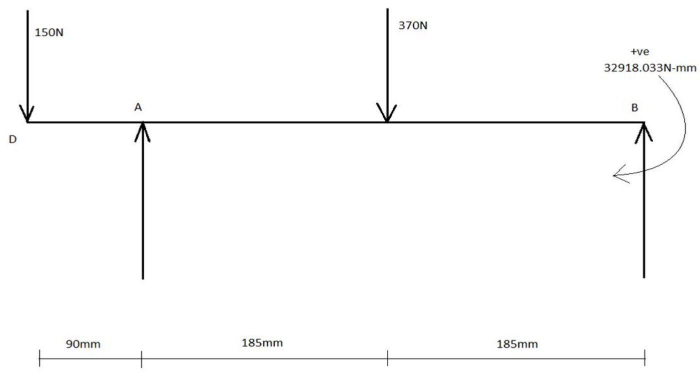


*Figure 8. Reaction at supports*

$$-150x460 + RA\, x370 - 370x185 + 32918.083 = 0$$

$$-69000 + 370RA - 68450 + 32918.033 = 0$$

$$370RA = +104531.967$$

$$RA = 282.52\, N$$

*Taking moment about point B for span BCEF*

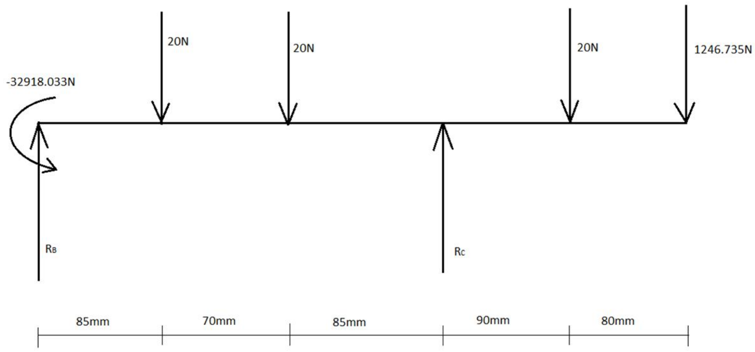


*Figure 9. Moments on main shaft*

$$1246.735x410 + 20x330 - RCx240 + 20x155 + 20x85 - 32918.033 = 0$$

$$511159.3 + 6600 - 240\, RC + 3100 + 1700 - 32918.033 = 0$$

$$-240\, RC + 489641.267 = 0$$

$$RC = 2040.172\, N$$

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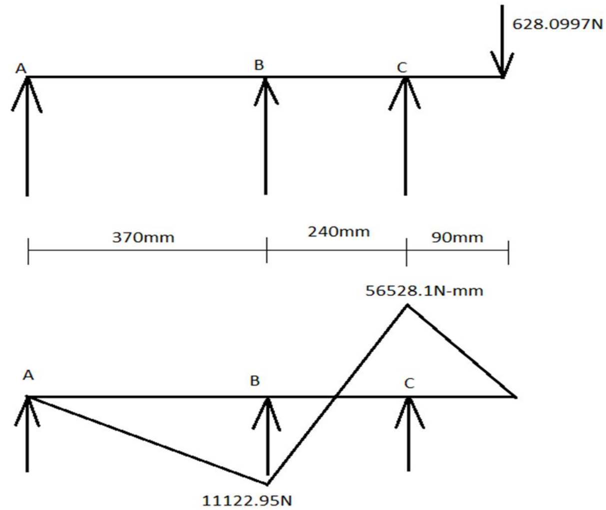
$RA + RB + RC = 1826.735\ N$

$282.52 + RB + 2040.172 = 1826.735$

$RB = -495.96\ N$

*2) In horizontal Reaction –*




*Figutre 10. Horizontal reaction*

*Span moment –*

*For both spans AB and BC Span moments are zero*

*Support moment calculation –*

$MA = 0$

$MB = ?$

$MC = 628.09x90$

$= 56528.1\ N - mm$

*Apply Three Moment Theorem (TMT) on Span AB and BC*

$MAxl1 + 2xMB(l1 + l2) + MC\ x\ l2 = (6xa1xx\bar{1})/\ l1 + (6xa2\ x\ x\bar{2})\ /\ l2$

$MA = 0$

$2MB\ (370 + 240) + 56528.1\ x240 = 0$

$1220\ MB = -13.57x\ 106$

$MB = -11122.95\ N - mm$

*Reaction calculation –*

$RA + RB + RC = 628.09$

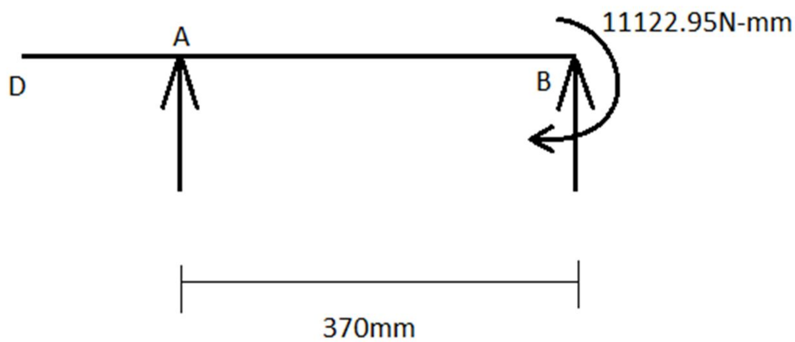



*Figure 11. Span moment*

*Taking moment about point B, for span AB*

$RA\ x370 + 11122.95 = 0$

$So, RA = 30.062\ N$

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*Taking moment about point B, for span BCE*

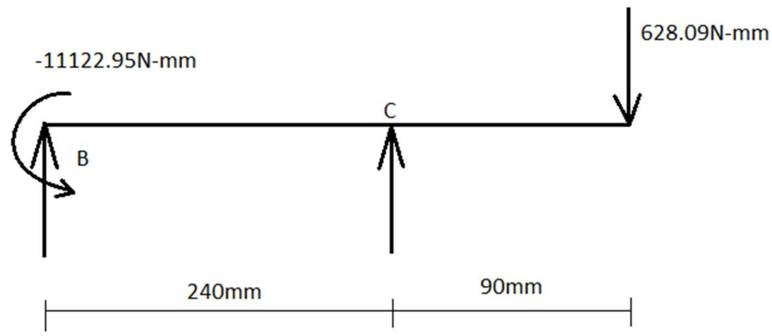


*Figure 12. Moment on main shaft*

$$-11122.95 - RC\,x240 + 628.09\,x330 = 0$$
$$-240\,RC = 817.28\,N$$
$$RA + RB + RC = 628.09\,N$$
$$RB + 30.062 + 817.28 = 628.09$$
$$So, \quad RB = -219.252\,N$$

$Maximum\ bending\ moment\ acting\ on\ shaft\ by\ considering\ both\ horizontal\ and\ vertical\ loads\ is\ at\ point\ C,$

$$MB = \sqrt{Mb\,v2 + Mb\,h2}$$
$$MB = \sqrt{213744..95^2 + 56528.1^2}$$
$$= 221093.486\,N - mm$$

*F. Design of Shaft-*

$The\ design\ of\ shaft\ is\ based\ upon\ equivalent\ torsional\ moment\ method.$

$The\ values\ of\ shock\ and\ fatigue\ factors\ are\ given\ on\ the\ basis\ of\ application\ of\ load.$

$For\ gradually\ applied\ load,$

$$Kb = shock\ factor = 1.5$$
$$Kt = fatigue\ factor = 1 \qquad \ldots[Table\ 9.2, Page\ No.\ 334, V.B.Bhandari]$$

$Material\ selection\ -$

$The\ material\ selected\ for\ shaft\ is\ Mild\ steel\ with\ grade\ 30C8$

$Properties: -$

$$Ultimate\ tensile\ strength = Sut = 500\,N/mm2$$
$$Yield\ strength = Syt = 400\,N/mm2$$
$$\ldots\ldots[Table\ 2.2, Page\ No.\ 31, V.B.Bhandari]$$

$The\ permissible\ shear\ stress\ can\ be\ given\ as,$

$$Ʈmax = (0.5Sut)/F.S.$$
$$Factor\ of\ safety = 2$$
$$Ʈmax = (0.5x500)/2$$
$$Ʈmax = 125\,N/mm2$$

$The\ shaft\ diameter\ is\ calculated\ by\ using\ equivalent\ torsional\ moment\ method,$

$The\ permissible\ shear\ stress\ can\ be\ given\ as,$

$$Ʈmax = 16x\sqrt{(Kb*Mb)^2 + (Kt*Mt)^2}/\pi xd3$$

$Putting\ all\ known\ values\ in\ above\ equation,$

$$125 = (16x\sqrt{(1.5*221093.48)^2 + (19.85*10*10*10)^2})/\pi\,xd3$$
$$d = 23.84\,mm \approx 35\,mm$$
$$d = 35\,mm \qquad -----diameter\ of\ shaft$$

*Bearing selection for Main shaft –*

*The support reaction are given as follow,*

$$RA = \sqrt{Rav^2 + Rah^2}$$
$$RA = \sqrt{282.52^2 + 30.062^2}$$
$$RA = 284.115\ N$$
$$RB = \sqrt{Rbv^2 + Rbh^2}$$
$$= \sqrt{(-495.96)^2 + (-219.252)^2}$$
$$RB = 542.261\ N$$
$$RC = \sqrt{Rcv^2 + Rch^2}$$
$$= \sqrt{2040.172^2 + (817.28)^2}$$
$$RC = 2197.78\ N$$

*Radial forces on bearings are,*

$$Fr1 = RA = 284.115\ N$$
$$Fr2 = RB = 542.261\ N$$
$$Fr3 = RC = 2197.78\ N$$

*There is no any axial thrust is acting on bearings,*

$$Fa1 = Fa2 = Fa3 = 0$$

*Dynamic load calculations*

$$P1 = Fr1 = 284.115\ N$$
$$P2 = Fr2 = 542.261\ N$$
$$P3 = Fr3 = 2197.78\ N$$

*Calculation of dynamic load capacity:–*

*The life of bearings selected is on basis of machine used for eight hours*

$L10h = 12000\ hr$ ... [*Table* 15.2, *Page No.* 573, *V. B. Bhandari*]

*Speed of shaft* $= 720\ rpm$

*Life of bearing in million f revolution is given as,*

$$L10 = (60xnx\ L10h)\ /106$$
$$= (60x720x12000)/\ 106$$
$$L10 = 518.4\ million\ revolution.$$

*Load factor* $= 2$ – – – – – *selected for V – belt drive*

... [*Table* 15.3, *Page No.* 573, *V. B. Bhandari*]

*Dynamic load capacity for bearing* 1 –

$$C1 = P1x(L10)1/3x(load\ factor)$$
$$= 284.115\ x\ 518.41/3\ x2$$
$$C1 = 4564.70\ N$$

*Dynamic load capacity for bearing* 2 –

$$C2 = P2x(L10)1/3x(load\ factor)$$
$$= 542.261\ x\ 518.41/3x2$$
$$C2 = 8712.16\ N$$

*Dynamic load capacity for bearing* 3 –

$$C3 = P3x(L10)1/3x(load\ factor)$$
$$= 2197.78\ x\ 518.41/3x2$$
$$C3 = 35302.35\ N$$

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Table 2. Bearing Specifications

| Parameter | Bearing 1 (16007) | Bearing 2 (6404) | Bearing 3 (6407) |
|---|---|---|---|
| Inner diameter | 35mm | 40mm | 35mm |
| Outer diameter | 62mm | 68mm | 100mm |
| Width | 9mm | 9mm | 25mm |
| Dynamic load carrying capacity | 12400N | 13300N | 55300N |
| Static load carrying capacity | 6950N | 7800N | 31000N |

## VII. DESIGNED HARVESTER

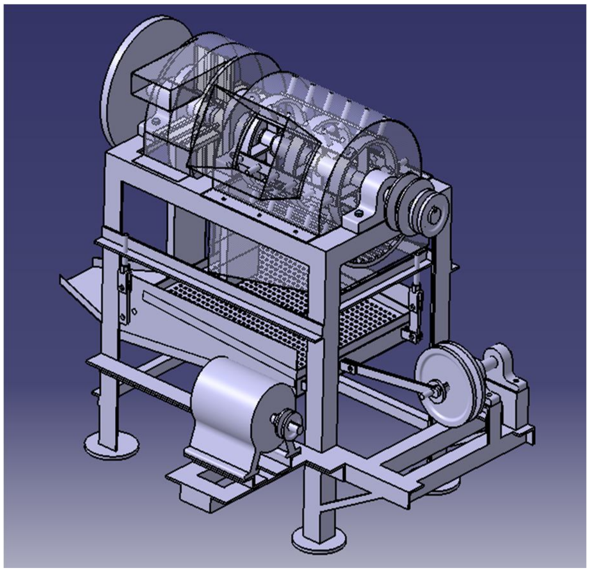

Figure 13. CATIA Model

Figure 14. Actual Model

## VIII. CONCLUSION

From all the experiments and trials, it is observed that the Harvester designed by us sufficed the actual needs satisfactorily with the following conclusions drawn out:

*A.* The purpose of reducing down the cost and capacity is achieved as far as the existing machines are concerned.

*B.* As per the Indian scenario, the per capita land owned by farmers is low making it obvious that they can't afford the existing machines. We achieved to maintain the cost around Rs.15000-18000.

*C.* The feed capacity is maintained around 50-100 Kg/hr.

*D.* Low maintenance and easy to operate due to simpler design.

*E.* All the parts are easily available in the market.

*F.* The harvester, being portable, can be carried to the farm with fewer efforts.

## IX. ACKNOWLEDGEMENT

We have taken sincere efforts for this project. However, it would not have been possible without the kind support & help of many individuals & organizations. We would like to extend our sincere thanks to all of them. We are highly indebted of Prof. V. D. Kamble and Prof. V.V. Gurav for their guidance & providing necessary information regarding the project & also for his support in completing the project. We would like to express our kind gratitude towards Prof. S. S. Mane (Head of Mechanical Engineering Department, K.I.T.'s College of Engineering) for his kind co-operation & encouragement which helped us in completion of this project. We would like to express our special gratitude & thanks to all teaching & non-teaching staff of Mechanical Engineering Department for giving us such attention & time. Also, we would like to thanks the person without whom it would be difficult to complete this project satisfactorily, Mr. Shankar Hatte and Mr. Ramesh Ghorpade (Samarth Engineering and Fabrication).

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## REFERENCES

[1] Design of Machine Elements by V. B. Bhandari.
[2] Strength of Materials by S. Ramamrutham.
[3] Theory of Machines by S. S. Ratan.
[4] Savant Agricultural Industry, Kolhapur.
[5] Agricultural Machinery Industry in India: A Study of Growth, Market Structure and Business Strategies by Sukhpal Singh
[6] Websites :www.engineershandbook.com,www.harvesting-machine .com,www.agriculturalproductsindia.com