# "Design and Fabrication of Canal Excavator"

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***Abstract:*** In day to Day life we face to the many problems in agricultural field for e.g. to excavate the canal in farm to make underground path for the pipeline. For that purpose we use the J.C.B machine or with the help of manpower. But in both the cases J.C.B very high cost and sometimes we use manpower and is very time consumable process.
For the same purpose the new intermediate option we going to design the new project or equipment "CANAL EXCAVATOR". This equipment is operate on the rated speed of tractor with the help of P.T.O (power take off) shaft. For power transmission we use the universal joint. And to dig out the sand we use the chain conveyor. The blade mount on the conveyor. To dig out the soil outside from canal we use the spiral type mechanism. This type of equipment reduced the operation time cost as well as efforts. The equipment is useful in agriculture.

***Index Terms*** **- Component, formatting, style, styling, insert.**

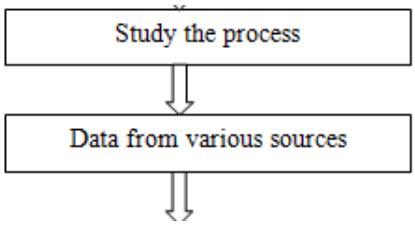
## I. INTRODUCTION

In the farm we need a proper irrigation for the crops or trees. Excavator consist a major role in agriculture. Irrigation in India includes a network of major and minor canals from Indian rivers, groundwater well based systems, tanks, and other rainwater harvesting projects for agricultural activities. Of these groundwater system is the largest.About 2/3rd cultivated land in India is dependent on monsoons. Irrigation in India helps improve food security, reduce dependence on monsoons, improve agricultural productivity and create rural job opportunities. Dams used for irrigation projects help produce electricity and transport facilities, as well as provide drinking water supplies to a growing population control floods and prevent droughts.
Now in the small sectors of land we use the underground irrigation system with the help of small tunnels and PVC pipelines. For this purpose we use the some small equipment to excavate the canal like Shovels and Spades, Grub hoe, Pick and Mattock. These are hand tools for excavate the soil with the help of human efforts. But this work is too hard and very time consuming process. After evaluation of new technology Sir. JOSEPH CYRIL BAMFORD founded first excavating machine which name has JCB in 1945 in England. After that JCB is sell in India also. For any purpose we use JCB like too dig out the soil from revers big canals to underground clogging the pipeline or lane cables. But for purchasing JCB is not economically possible for any person as well as for rent it.
Hence according to Economical analysis we design the new equipment which name having "CANAL EXCAVATOR". Is reduced the efforts of human being and also in available in low cost as well as in simple design.

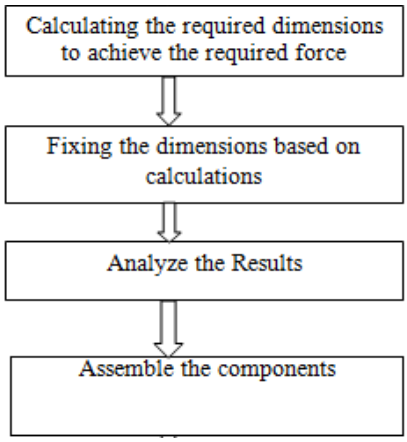
## II. PROBLEM STATEMENT.

To manually dig out the soil in the farm with the help of small equipment like Pick and Mattock and grub hoe. We require the labour power in short human efforts. So this process required more time to digging the soil. Minimum 3-4 days. After that labor clogging the PVC pipes. This process is very time consumable.
After that farmers are use JCB machine on rent. Minimum rent of JCB is Rs. 800/hr. and is not Affordable for each person. Some fruit trees are used for life long production like pomegranate trees, grapes trees. In that farm plantation is done by some standard spacing between two trees i.e. 9×12 or 12×14. In such that condition JCB can't enter in such small spacing for making the underground irrigation pipeline canal.
Hence to overcome these problem we design the new equipment called "CANAL EXCAVATOR".

## III. RESEARCH METHODOLOGY.






**3.1 Study the process.**

In agriculture field proper irrigation is one of the most important process. Hence various type of irrigation used in the farming process like drip, sprinklers. To circulate the water as per our requirement from the reservoir to the planted crops generally use the underground pipeline is used after that study the existing process of the making canal for underground pipeline. Observe the problems will have to face.

**3.2 Data from various sources.**

After survey to overcome the problems of to making the canal for underground pipeline we observe the disadvantages of the existing trenching system these machineries are too much large in size it requires a very large space. It can't enter in the small in space hence after study of the literature of the existing trenchers on the basis of design what mechanisms we used in simple in design to reduce the costing of equipment.

**3.3 Calculating the required dimension.**

To construct the actual design of themodel firstly studied that spacing in between two trees. In witch can enter the tractor on which we assemble the new model. After that take the specific measuring the dimension and design the model on the software like cad, catia. And analyzes the model as per the design structure by trial and error method. After the calculations of the forces and stresses decide the selection of the material.

**3.4 Analyze the results.**

Selection of the material to various components like shaft, support framework, sprockets, etc. on the selected material various test conducted like hardness test. After the results manufacturing of the components.

**3.5 Assemble the components.**

After manufacturing the all components proper assemble the all components in sequential manner with the help of various processes like fastening, welding, pin join, hook join.

## IV. DESIGN OF COMPONENTS IN CANAL EXCAVATOR.

**4.1 Design of shaft.**

In any type of the mechanical system components transmission play the major role in the gearbox. And for the transmission we used the shaft. Some assumptions we have to consider for design the shaft also the mechanical properties of the material, like strength, hardness, temperature, output torque etc. here we have to use the 35hp tractor as a drive for transmit the power through the shaft. Hence we design the shaft mathematically are as follows.

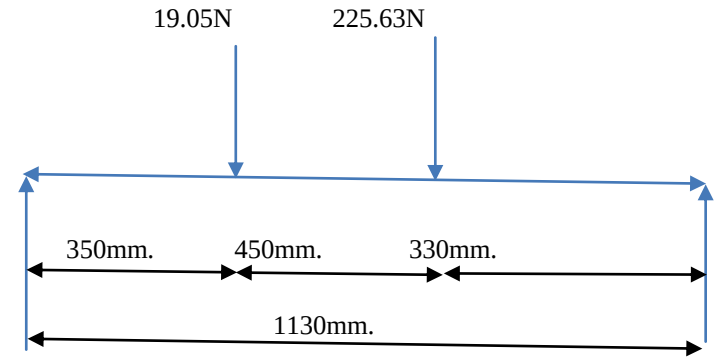
For calculate the power in kilowatt.

$P = 35 \times 0.746.$

$P = 26.0995$ kw.

$P = 26.0995 \times 10^3$w.




Weight of the Sprocket is 2kg.
= 2×9.81
= 19.62 N.
Weight of the Gearbox is 23kg.
= 23×9.81
= 225.63N.
Syt = 50 $N/mm^2$ (Because the material of shaft mild steel for heavy load.)
In allowable shear stress theory.
$\tau = 0.3 \times Syt.$
$\tau = 0.3 \times 50.$
$\tau = 15 N/mm^2.$
The shaft will be designed based on twisting moment and bending moment.
Power transmitted by shaft by using the following formula;
Mathematically;
$p = \frac{2\pi NT}{60}.$
Where,
P = power.
N = speed in rpm.
T = torque transmitted by shaft.
Now we know the parameter.
$26.099 \times 10^3 = \frac{2\times\pi\times636\times T}{60}.$
T = 391.65 *N.mm*
$T = 391.65 \times 10^3\ N.mm$
To calculate the reaction at the support.
$R_a+R_b$= 245.25 N.
$R_b = \frac{19.62\times350\times225.63\times800}{1130}$
$R_b$= 165.81 N.
$R_a+R_b$= 245.25 N.
$R_a$+165.81 = 245.25 N.
$R_a$ = 79.43 N.
Calculate the bending moment along the point C and D.
Bending moment at C = 350×379.43.
C = 27800.5 N.mm
Bending moment at D = $R_b$× 330.
D = 165.81×330.
D = 54717.3 N.mm
Calculate the equivalent torque.
$T_{eqc} = \sqrt{T^2 + M^2}$.
$T_{eqc} = \sqrt{(391.65 \times 10^3)^2 + (27800.5)^2}.$
$T_{eqc}$= 392635.44 N.mm
$T_{eqd} = \sqrt{T^2 + M^2}$.

$T_{eqd}= \sqrt{(391.65 \times 10^3)^2 + (54717.3)^2}$.
$T_{eqd}$= 395453.79 N.mm
By comparing both the equivalent torque from that we select the maximum value of the torque.
Mathematically by using the following formula,
$T_{eq}=\frac{\pi}{16} \times D^3 \times \tau$.
$395453.79=\frac{\pi}{16} \times D^3 \times 15$.
$D^3 = \frac{395453.79 \times 16}{\pi \times 15}$.
D = 51.20 mm. (Approximately 52mm.)

**4.2 Design of the chain.**
To drive the any type of system we have to use transmission systems we have to use like gear pear, belt and pulley, chain and sprocket. But here center distance of two drive is two long hence we cannot use the gear transmission. Another option is belt drive but here high torque will be generate that's why slippage is occur to overcome these problem we used the chain and sprocket transmission. Because of the using the chain and sprocket arrangement we avoid the problem of slippage. And maintain the proper transmission of the drives.
Mathematically we select the design of chain are as follows:
As per the selection of tractor rpm 1000. The output shaft of the gear box is rotate with 637 rpm.
Given, $S_1$ = 637. $S_2$ =?
$S_2 = (Z_g/Z_p) \times S_1$.
$S_2$ = (30/17)×637.
$S_2$ = 1124.11
For the calculation of chain length.
Mathematically, Designation of chain is as 12B-1.
Where,
C.D= Center distance between two sprockets.
$Z_g$= Number of teeth on larger sprocket.
$Z_p$= Number of teeth on smaller sprocket.
Y= Pitch angle.
D= Diameter of sprocket.
When,
Y= 360/Z.
$Y_g$= 360/30.
$Y_g$= 12.
$Y_p$= 360/17.
$Y_p$= 21.17.
From the above designation pitch of the chain is 19.05.
By using the formula: (For larger diameter of sprocket).
$\sin\frac{Y}{2} = \frac{P/2}{D/2}$.
$\sin\frac{12}{2} = \frac{19.05/2}{D/2}$.
D = 182.24 mm.
By using the formula: (For smaller diameter of sprocket).
$\sin\frac{Y}{2} = \frac{P/2}{d/2}$.
$\sin\frac{12}{2} = \frac{19.05/2}{d/2}$.
d = 103.70mm.
Now calculate the average velocity, by using the following formula.
$V = \frac{ZPn}{60 \times 1000}$.
$V = \frac{30 \times 19.05 \times 637}{60 \times 1000}$.
$V = 6.06 {}^{m}/_{s}$.
For the smaller sprocket.
$V = \frac{ZPn}{60 \times 1000}$.
$V = \frac{30 \times 19.05 \times 1124.11}{60 \times 1000}$.
$V = 10.70 {}^{m}/_{s}$.
By using the following formula we can calculate the speed ratio (i).
$i = \frac{n1}{n2} = \frac{Z2}{Z1}$.
$i = \frac{637}{1124.11} = \frac{17}{30}$.

i = 0.56
To calculate the number of links in the chain by using the given requirement are as follows:
Given,
C = It indicates the center distance of the two sprockets.
P = It indicates the pitch of the chain.
$Z_g$ = Number of teeth on large sprocket.
$Z_p$ = Number of teeth on large sprocket.
M = Number of links.
By using the formula:

$$M = 2\times\frac{C}{P} + \frac{Zg+Zp}{2} + \left(\frac{Zg-Zp}{2\pi}\right)^2 \times \frac{P}{C}.$$

$$M = 2\times\frac{1100}{20} + \frac{30+17}{2} + \left(\frac{30-17}{2\pi}\right)^2 \times \frac{20}{1100}.$$

$M = 134.$
Number of links in the chain is 134.
Now total length of the chain (L).
L = M×P.
L = 134×20.
L = 2671.55mm.
L = 2671.55 is approximately 9 foot.

### 3.3 Theoretical design of hydraulic cylinder.

In the canal excavator to maintain the pressure on the rotor blades we have to use the double acting hydraulic cylinder as shown in fig. and this pressure is balance with the help of direction control valve. To design the hydraulic cylinder we have to take some assumption here we assume the 70 bar pressure we have to required.
Calculate the diameter of the cylinder with the help of force and pressure.
$f_e$ = force at extension is 80 kg.
$f_r$ = force at retraction is 150 kg.
Mathematically;

$$fe = \frac{\pi D^2}{4}.$$

$$D = \sqrt{\frac{4fe}{P\pi}}.$$

$$D = \sqrt{\frac{4\times(80\times9.81)}{(70\times10^5)\pi}}.$$

$D = 0.01194$ m.
$D = 11.94$ mm.
Now for retraction.

$$fr = \frac{\pi D^2}{4}.$$

$$D = \sqrt{\frac{4fr}{P\pi}}.$$

$$D = \sqrt{\frac{4\times(150\times9.81)}{(70\times10^5)\pi}}.$$

$D = 16.36$ mm.
From the above calculations we select the maximum bore diameter.

| **Model.** | **Bore diameter.** | **Rod diameter.** | $D^2 - d^2$ |
|---|---|---|---|
| $A_1$ | 25 | 12.5 | 468.75 |
| $A_2$ | 40 | 16 | 1344 |
| $A_3$ | 50 | 35 | 1275 |
| $A_4$ | 75 | 45 | 3600 |
| $A_5$ | 100 | 50 | 7500 |

Table: - Given models of hydraulic cylinder.
From the above calculation we select the maximum bore diameter and we select the standard bore diameter for the hydraulic cylinder from the given table is as 25×12.5.

### 3.4 Design of gearbox.

To transmit the power from PTO we use bevel gear box. Because power transmit in perpendicular manner. Gear box consist two shafts input and output shaft. On input shaft pinion having 14 number of teeth. And output shaft having 22 number of teeth.
Calculation for pitch cone angle (γ) for gear and pinion.
For pinion.
$\tan(\gamma_p) = Z_p/Z_g.$

$\gamma_p = \tan^{-1}(Z_p/Zg)$.
$\gamma_p = \tan^{-1}(14/22)$.
$\gamma_p = 32.47$.
For gear.
$\gamma_g = (90\text{-}32.47)$
$\gamma_g = 57.52$
Now calculation for rpm.
Case I: - Given input rpm of tractor is 540.
By using formula.
$Z_g/Z_p = N_p/N_g$
$22/14 = 540/N_g$
$N_g = 344$ rpm.
This gear train having two sprocket gear pair, A, B, having 30, 17. Number of teeth respectively.
Find the rpm of each gear pair
Given: - $N_g = 344$ rpm, $Z_g = 30$, $Z_p = 17$.
Find: - $N_p$ =?
$Z_g/Z_p = N_p/N_g$.
$30/17 = N_p/ 344$.
$N_p = 607$ rpm.
Case II: - Given input rpm of tractor is 1000 rpm.
Now, as we know formula.
Given: - $N_g = 1000$, $Z_p = 14$, $Z_g = 22$.
$Z_g/Z_p = N_p/N_g$.
$22/14 = N_p /1000$.
$N_g = 1570$ rpm.
Now second sprocket gear pair.
Given: - $N_g = 1570$ rpm, $Z_g = 30$, $Z_p = 17$.
Find: - $N_p$ =?
$Z_g/Z_p = N_p/N_g$.
$30/17 = N_p /1570$.
$N_p$ =2770 rpm.
From above calculation working rpm 607 and 2770. As we know that when torque is increases then rpm is reduces. From trial and error method we decide which rpm to excavate the soil is feasible.

## V. ACKNOWLEDGMENT

Thepreferredspellingoftheword "acknowledgment" inAmericaiswithoutan "e" afterthe "g".Avoidthestiltedexpression, "Oneofus(R.B.G.)thanks..."
Instead,try"R.B.G.thanks".Putapplicablesponsoracknowledgmentshere;DONOTplacethemonthefirstpageofyourpaperorasafootnote.

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