DESIGN OF RIDGE PLASTERING ATTACHMENT FOR POWER TILLER

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PROJECT REPORT

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DECLARATION

We hereby declare that this project report entitled **"DESIGN OF RIDGE PLASTERING ATTACHMENT FOR POWER TILLER"** is a bonafide record of project work done by us during the course and that this report has not previously formed on the basis for the award to us of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

Place : Tavanur

Date : /06/2022

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CERTIFICATE

Certified that this project report entitled **"DESIGN OF RIDGE PLASTERING ATTACHMENT FOR POWER TILLER"** is a record of project work done jointly by **Ms. Gayathri M Pillai, Ms. Parvathi M Binod, Ms. Haritha S, Ms. Jyothikrishna S** under our guidance and supervision and that it has not previously formed the basis for any degree, diploma, fellowship or associateship or other similar title of another University or Society.

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SYMBOLS AND ABBREVIATION

Abbreviation/Notation	Description
/	Per
º	Degree
ºC	Degree Celsius
%	Percentage
3D	Three dimensional
Asst.	Assistant
Ag.	Agricultural
CAD	Computer aided design
CAE	Computer aided engineering
cc	Cubic centimetre(s)
cm^2	Square centimetre(s)
cm^3	Cubic centimetre(s)
Dept.	Department
db	Dry basis
Engg.	Engineering
et al.	And others
etc.	Et cetera
Fig.	Figure
FMPE	Farm Machinery and Power Engineering
gcc^{-1}	Gram per cubic centimetre
GDP	Gross Domestic Product
h	Hour
ha	Hectare
hah^{-1}	Hectare per hour
hha^{-1}	Hour per hectare
hp	Horse power
i.e.	That is
ID	Inner Diameter

KAMCO	Kerala Agro Machinery Corporation Ltd
KAU	Kerala Agricultural University
KCAET	Kelappaji College of Agricultural Engineering and Technology
kg	Kilogram
$kgfcm^{-2}$	Kilogram force per square centimetre
kgf	Kilogram force
$km\ h^{-1}$	Kilometre per hour
l	Litre
ls^{-1}	Litre per second
lh^{-1}	Litre per hour
lha^{-1}	Litre per hectare
$l\ min^{-1}$	Litre per minute
mm	Millimetre(s)
mm^2	Square millimetre(s)
m	Metre(s)
m^2	Square metre(s)
m^3	Cubic metre(s)
mh^{-1}	Metre per hour
$MJ\ h^{-1}$	Mega Joule per hour
ml	Millilitre
ms^{-1}	Metre per second
$m^3\ s^{-1}$	Cubic metre per second
MPa	Mega Pascal
MS	Mild steel
N	Newton
Nm	Newton metre
OD	Outer diameter
PTO	Power Take Off
rpm	Revolution per minute
Rs.	Rupees

s	Second
sm^{-2}	Second per square meter
US	United States
V	Volt
W	Watt

CHAPTER I

INTRODUCTION

Agriculture or farming is the practice of cultivating plants and livestock. It was the key development in the rise of sedentary human civilization, whereby farming of domesticated species created food surpluses that enabled people to live in cities. The history of agriculture began thousands of years ago. After gathering wild grains beginning at least 105,000 years ago, nascent farmers began to plant them around 11,500 years ago. Pigs, sheep, and cattle were domesticated over 10,000 years ago. Industrial agriculture based on large-scale monoculture in the twentieth century came to dominate agricultural output, though about 2 billion people still depended on subsistence agriculture. The history of agriculture in India dates back to the Indus valley civilization. India ranks second worldwide in farm outputs. In 2022, agriculture and allied sectors like animal husbandry, forestry and fisheries accounted for 8.7% of the GDP (gross domestic product) with about 41.19% of the workforce in 2020.India ranks first in the world with highest net cropped area followed by US and China. According to the economic survey, the share of agriculture in gross domestic product (GDP) reached almost 20% for the first time in 17 years, making a sole bright spot in performance during financial year 2020–2021.

Kerala, the State with network of azure backwaters, rivers and streams, boasts of an agrarian economy. The abundance of water due to the 34 lakes and other small streamlets, innumerable backwaters and water bodies and 44 rain-fed rivers flowing over the terrain of the state and also the adequate annual rainfall of 3000 mm received by this state probably facilitates agriculture to a great extent and hence the economy of the state is dominated by agriculture. The growth performance of the agriculture and allied sectors has been fluctuating across the plan period. It witnessed a positive growth of 1.8 percent in X plan period but a negative growth rate of -1.3 percent in XI Five Year Plan.

Paddy one of the major food grains in our country. Very few crops achieved mechanization from land preparation to harvesting among those crops, paddy is one. After harvesting the straw or stubble is left in the field of other crop, but for paddy special machines are available for collection of straw. About 600 varieties of rice are grown in the sprawling paddy fields of Kerala. Many paddies are flooded by rivers and rainfall during monsoon season, while others must be irrigated. The paddies have an impermeable subsoil and are bordered by earthen bunds to hold an average of 4-6 inches (10-15 cm) of water in the field for three-quarters of the growing season. In all countries, excluding India, paddies are worked by family labour alone and by the same methods as were used 2,000 years ago such as hand cultivation with hoe and spade, or water-buffalo-, horse-, or ox-drawn plough with metal share.

Mechanisation of small and marginal farms is gaining importance in our country as an essential step to increase the timeliness of operation as well as to reduce the labour requirement and cost of cultivation. Agricultural mechanization can simply define as the use of any machine to accomplish a task or an operation involved in agricultural production. Such tasks or operations include reduction in human drudgery, improvement in the timeliness and efficiency of various agricultural operations, bringing more land under cultivation, preserving the quality of agricultural products, providing better rural living conditions, and markedly advancing economic growth. At present the tractors and powertillers are easily available for the farmers to carry out almost all the tillage operations like ploughing, puddling, levelling as well as transportation. But sowing, transplanting, harvesting, threshing, winnowing is still done manually mostly with traditional equipments which are insufficient.

The ridge preparation is one among field operation in which bunds or ridges are simply embankment like structures, constructed across the land slope to retain water in low land transplanted rice system. Ridges are required to hold water in between them and prevent breaching of water from field to field. The bunds cannot be formed until the rice has been seeded and after the rice has been transplanted, there is limited time to get the bunds constructed and firmed before a rain occurs. The method of planting on raised ridges is best used when poor soil drainage is a problem, where flood type irrigation is used, or where heavy rains occur. Ridges are usually made 8-12 inches high, depending on the drainage of the soil. They are 30 to 36 inches wide, depending on the crop to be grown. For example, a narrow ridge is used for single row crops like corn and wider ridges are used for double or triple row crops like lettuce or cabbage.

Ridge plastering, an operation where field bunds are trimmed and thereafter plastered and compacted using the earth excavated, was being done manually. In traditional method, bunds are usually done in two steps at the beginning of each crop season. First, the bund should be cleared from weeds and grass before initial ploughing. Then the bund should be plastered with a layer of mud after the second plough. The shape of bund formed in pulverised/cultivated field with bund former is triangular. After manually packing/firming of formed bund, it becomes trapezium shaped. Good bunds help to limit water losses by seepage and under bund flows. Bunds should be well compacted and any rat holes should be plastered with mud.

Manually, an average skilled person can trim and plaster 90-120 m of bund per day. Normally, a person can pack or firm the formed bund 100-150 m length in an hour (Singh *et al*., 2016). An average farmer would take approximately 30 minutes for single side bund clearing and 45 minutes for single side bund plastering of 18 m long bund (Pathirana *et al*., 2010). The traditional manual bund/ ridge forming work is characterised by low efficiency, low strength, high cost and directly affects the profitability of rice farming. More over manually made bunds that are not properly aligned and compacted, not last for long and causing rodent problem.

Therefore, the mechanization of bund or ridge forming is an important process in the preparation of the rice field before transplanting. The ridge plastering machine will strengthen the existing ridge without damaging the height of the ridge by adding on the side walls. The tractor operated ridge machine consists of three major components namely, rotavator, forming roller and rotating disc. A rotary tiller, also known as a rototiller, rotavator, rotary hoe, rotary plough, is a motorized cultivator that works on the soil by means of rotating tines or blades. The purpose of a rotovator is to break up the soil so that planting (either of crops or plants, mostly seeds) can take place. They do not dig deeply into the soil, but will turn the soil. The rotovator in the Ridge plastering machine consists of 8-tynes and attached to the tractor by means of a three-point hitch and driven by a power take off (PTO) shaft.

The purpose of forming roller in the ridge plastering machine is to prepare the irrigation plot in a way such that no high and or low spots disturb the uniform distribution of irrigation water on the field, and ensuring the optimal slope for water movement across a field when irrigated. Proper levelling leads to more efficient use of irrigation, fertigation and chemicals could be possible in the field. And also results in efficient soil aeration and water uptake by crops. The purpose of rotating disc in the ridge plastering machine is to trim the bund and plaster it with pulverized soil so that the bund will be having a smooth finish with the help of roller attached to the disc.

The merits of tractor operated ridge plastering machine are that rodents can be controlled by this machine due to its effective trimming, plastering and compaction. It decreases the cost of operation about Rs. 2000-2500/- over traditional methods. The ridge plastering machine has an output of 900-1000 m/hr. It helps to reduces the time of operation for making of bunds over traditional manual bunding. It reduces about 96 % dependency of farmers on manual labour requirement for bunding.

The drawback of the existing mechanized bund plastering method is that the combined weight of Cat-II tractors and ridge plastering machine results in sinkage of the machine in puddled field. The tractor operated ridge plastering machine is of huge cost and less likely affordable. It is also not suitable for small land preparations.

Keeping the above points in view, the study was made to design power tiller operated ridge plastering machine which enables combined operation of ridge making and plastering. This machine will be suitable for both dry and wet conditions. A local made or modified machines can bring down the cost. Hence, a simple, effective and indigenous power tiller operated machine was designed for small and marginal farmers.

The present investigation was undertaken with the following objectives:

1. To study engine and transmission systems of KAMCO power tiller for the design of ridge plastering attachment.
2. To study the features of different tractor operated ridge plastering machines.
3. To design ridge plastering attachment to KAMCO power tiller.

CHAPTER II

REVIEW OF LITERATURE

In this chapter, the comprehensive review of the research work done by various research workers relevant to the present study is summarized and presented.

2.1. STUDIES ON EXISTING METHODS OF RIDGE PLASTERING

Ryals (1984) invented rice levee shaper and packer related to agricultural equipment and useful for rice levee construction and more particularly for the controlled, efficient, convenient, shaping and packing of rice levees. Further object of this invention provided design of machine to prevent the caking and accumulation of wet or clay soil thereon, thereby allowed levee formation under adverse soil conditions.

Kawahata *et al.* (1997) worked on 'Application of a three-dimensional reconstruction method to analysis of the residual ridge'. A new method of analysing the shape of the residual ridge was found out. The line of the residual ridge crest was regarded as the reference for artificial tooth arrangement and a method of determining it was evaluated. The shape of a plaster model was measured with a contact-type shape measurement system. The measurement data in each frontal section were interpolated by cubic splines. The points corresponding to the residual ridge crest were calculated and superimposed onto the image of the plaster model on a monitor screen of an image processor. Using these points and the image of the plaster model, the line of the residual ridge crest was marked on the plaster model. The method can be used to determine the line of the residual ridge crest on a plaster model.

Chenhuang *et al.* (2003) worked on 'Analysis of percolation and seepage through paddy bunds'. Field experiments were conducted in Hsin-Pu of Hsin-Chu County, Taiwan, to measure the soil water content of various bund types. Results indicates that the soil was unsaturated along the sloped surface of the terrace. It was also found out that seepage face flow did not develop even after 2 days of heavy rainfall. A three-dimensional model, FEMWATER, was adopted to simulate percolation and lateral seepage under various bund conditions. The percolation of the bund without plow sole was 0.85 cm d^{-1} infiltration in the central area of a terraced paddy is mainly vertically downward, whereas flow near the bund is predominantly lateral. The paddy field near the bund has a high hydraulic gradient. The simulated infiltration flux into the bund (1.47 cm d^{-1}) after 85 days of rice cultivation exceeded that into the central area (0.54 cm d^{-1}) by a factor of 2.72. The final percolation flux from the bund (1.24 cm d^{-1}) also exceeded the final percolation from the plow sole (0.68 cm d^{-1}) by a factor of 1.82. The lateral seepage fluxes through the bund, downward and upward along the slope surface, are 2.01 and 22.12 cm d^{-1}, respectively. Both experimental and simulation results clarify the mechanisms of water movement in the terraced paddy and reveal the existence of an unsaturated seepage face along the sloping surface of the terraced field.

Pathirana *et al.* (2010) worked on 'Sustainable farming through mechanization: development of a bund making machine'. For bund clearing, a simple cutter with a height adjusting mechanism and rotary blade arrangement had been developed and tested for two-wheel tractor. When the moisture content increases, the bund formation was not successful. The drum should rotate at a high speed to form a well compacted bund. There was another attachment only for bund clearing built by a Sri Lankan farmer for two-wheel tractors. A plastering technique was suggested which include a channel to convey mud when it moves forward with the tractor and direct mud towards the bund. This was fabricated using steel sheets and cost of fabrication approximates Rs. 6000.

Fakruddin (2018) has worked on development of bund trimming and plastering equipment for rice fields. In his study, the rotation of cutter is used to resize the bund and plastered soil after cutting was used for strengthening bund with the help of pressing roller. The optimal operating forward speed was found to be 1.6 kmh^{-1}, the machine achieved maximum bund trim efficiency and degree of compaction as 80.17% and 90.11% respectively with a fuel consumption of 2.53 lh^{-1} was found to the operation. The energy requirement was maximum as 160.33 MJh^{-1} at a speed of 3.0 kmh^{-1} and minimum as 98.76 MJh^{-1} at a speed of 1.6 kmh^{-1}. The research paper showed that effective bund trim capacity and the volume of soil handled by the bund trimmer increased with increase in the tractor speeds while the bund trim efficiency and degree of compaction started decreasing with increase in tractor speed. The average cost of operation was Rs. 484 per hectare.

Rajaiah *et al*. (2020) worked on 'Development and evaluation of mini tractor operated ridge plastering machine’. A mini tractor operated ridge plastering machine was developed at FIM, Scheme, Rajendranagar, Hyderabad, Telangana and evaluated in sandy loam soil with a moisture content of 31%. The machine can be operated with 18-25 hp range mini tractors. This attachment weighs about 390 kg with overall dimensions of 1,620 mm length, 1,660 mm width and 1,130 mm height. The roller attached to the rotating disc compresses the soil. During the field study, it was observed that, the field capacity of the machine was 833 m per hour with an average speed of 1.0 km/h. Overall dimensions of bund was 178 mm height and 288 mm width respectively. The angle between ground and the side wall of the bund is 120º. The fuel consumption of the machine was 3.42 l/h. The cost of operation of the machine was Rs. 700-800/ h.

2.2. STUDIES ON EVALUATION OF PERFORMANCE OF BUND FORMING OR PLASTERING EQUIPMENT

Lewis *et al.* (1962) conducted an experiment on plastic rice bunds to overcoming the limitations of earth bunds. For this study five plots were placed at random along each of two bunds in three rice fields. The three fields contained with plastic bunds, three-year-old soil bunds and new soil bunds with carefully graded borrow pits. Use of plastic bunds for rice production could result in earnings of about one and a half times the extra cost as compared with soil bunds. The study shows that the increased yields per acre result from production on land otherwise taken up by soil bunds. Plastic bunds savings in time, labour and machinery were possible in tillage and harvesting operations. Plastic bunds field required 12.5% less tillage time than the three-year old soil bund field. Plastic bunds save an average cost of Rs. 532.82 per hour for tillage.

Singh *et al*. (2016) conducted research on "Development of tractor operated bund former-cum-packer for increasing resource productivity”. A rectangular tool-bar frame of differential height for bund forming and bund packing operations was designed. The width of rectangular tool bar frame was kept in such a way that conical disc of bund packer starts packing of bund just after soil thrown by the bund former during bund formation. Thus, distance between disc of bund former and bund packer is kept about 450 mm. Increasing the tractor forward speed from 2nd low to 3rd low gear, it was observed that less compaction occurred from side as well as top. Therefore, the bund former-cum-packer was operated in the pulverised fields at speed of 2.85-2.93 km/h (2nd low gear) while only bund former was operated at speed of 3.95 km/h. The soil moisture content varied from 6.95 to 10.37%. The bulk density of manually packed bund (formed by bund former) was found highest (1.286 g/cc) compaction from top of bund, whereas it was lowest (1.256 g/cc) in the bund formed by bund former after a day. No seepage and spillage were observed. The fabrication cost of the equipment was worked out to Rs. 50,870. The field capacity with the equipment was 1.4 ha/h at tractor speed of 2.93 km/h in 2nd low gear. Overall use of the equipment is having potential to increase the resource productivity by 38%.

Rahul *et al*. (2018) conducted a study on the "performance evaluation of tractor operated ridge plastering machine". The performance of tractor drawn ridge plastering machine was evaluated in the field conditions at FIM, Scheme, Rajendranagar, Hyderabad, Telangana in sandy loam soil with a moisture content of 13.87 % (db.). The machine can be operated with 40-70 hp tractors. The attachment weighs about 390 kg with 1.62 m length, 1.66 m width and 1.13 m height. The angle between ground and the side wall of the bund is 120º. The fuel consumption of the machine was 4 l/h. The cost saving was Rs. 2248/- over conventional method. From the results, the forward speed observed was 1.152 km/hr for black soils and 1.94 km/hr for the sandy soils. The speed of the rotating disc and rototiller were found to be 227 rpm and 238.6 rpm respectively. During the field study it was observed that, the rate of work of the machine was 1000 m per hour at an average speed of 1.0 km/h with the height and width of bund was 25 cm and 45 cm respectively. The cost of ridge plastering machine was Rs.3.0 lakh.

CHAPTER III

MATERIALS AND METHODS

This chapter deals with the tractor operated ridge plastering machines, its specifications, components and constructional details. This also discuss about the ridge plastering attachment for power tiller, its technical specifications and design modifications. Torque power curve and design of different transmission components are explained.

3.1. INTRODUCTION TO TRACTOR OPERATED RIDGE PLASTERING MACHINE

The ridge plastering machine is a tractor attached implement that will build new bunds or field ridges and also strengthen the existing bunds/ field ridges at high speed while making them stronger and aesthetically much better. It is suitable for both dry and wet conditions. In ridge plastering, field bunds are trimmed and thereafter plastered and compacted. The ridge plastering machine will strengthen the existing ridge without damaging the height of the ridge by adding on the side walls.

3.1.1. Machine 1 – Redlands Ridge Plastering Machine

Redlands ridge plastering machine as shown in fig 3.1 is suitable for both dry and wet conditions. Reverse ridging is also possible. The power requirement is of category II tractors is 42 hp. The water in the field should be drained for a day or two before commencing the ridge plastering operations. During operation the machine receives the drive from tractor PTO through universal telescopic shaft which transfers power to the input shaft of chain drive system. The drive from the chain sprocket system is transferred to the two similar bevel gear boxes with miter gears connected in series enables the working unit of the machine to swing side wise. Then the drive from the bevel gear box is transferred to the chain drives of ditching unit and plastering unit through chain and sprocket. The ditching unit attached with L shaped blades which ditches and throw the soil against the guard cover. The thrown soil is pressed against the ridge wall and plasters side and top surface of the ridge. The firming roller presses the top land of the ridge and plasters the top surface. The specifications of the ridge plastering machine are shown in table 3.1.

Fig 3.1. Redlands ridge plastering machine

Table 3.1. Specifications of ridge plastering machine- RRM 700

S. No	Particulars	Specifications
1	Purpose	For bund side ploughing
2	Reverse ploughing	Provided
3	Tractor power required, hp	30-70
4	PTO speed, rpm	540
5	Operating speed, km/h	0.5 to 1.7
6	Overall dimensions, (L x W x H), mm	1620 x 1660 x 1130
7	No. of blades on roto tiller	10
8	Working width of roto tiller, mm	340
9	Length of leveling roller, mm	220
10	Weight, kg	390
11	Diameter of leveling roller, mm	170
12	Cost of the machine, Rs.	3,00,000/-

The ridge plastering machine RRM-700 is operated by a 45 hp tractor. The rotary plough for bund side ploughing machine will strengthen the existing bund (ridge) without damaging the height of the ridge/bund by adding on the side ways. This machine will work well in the soil moisture range of 30 to 60 %. The machine is operated using the power of a 40-70 hp tractor upon which it is mounted. The attachment weighs about 390 kg with 1.62 m length, 1.66 m width and 1.13 m height. The hydraulic power of the tractor is used to change the direction of operation. The PTO (power take-off) drive is connected to the transmission unit of the rotary plough bund side ploughing machine from where the power is distributed to the three rotating parts. The machine has a ten-tyne rotavator, a forming roller, a rotating disc of 700 mm diameter and a 220 mm long roller. The rotavator pulverizes the soil, the forming roller levels the soil, and the rotating disc trims the bund and plasters it with pulverized soil. The roller attached to the rotating disc compresses the soil.

3.1.1.1. Frame

The main frame consists of three portions i) 3-point linkage mounting frame, ii) swinging frame where the bevel gear boxes are fitted and iii) mounting frame in which the ditching and the plastering units are mounted. The 3-point linkage frame is made out of 50 mm square pipe welded to form a rectangle with which hinge plates are welded. The swinging frame is similar to the 3-point linkage mounting frame with hinge plate welded. These two frames are connected by two connecting frame which enables the swinging frame to move sidewise.

3.1.1.2. Main input drive system

It consists of a chain drive case in which the driver sprocket is fitted with the input shaft and the output shaft is mounted on the driver sprocket.

Type of drive	:	Chain & sprocket
No. of teeth on the driver sprocket	:	13
No. of teeth on the driven sprocket	:	14
Speed reduction ratio from input shaft to output	:	1:0.93
Oil capacity	:	400 grams - AP3 grade grease

Details of chain

Type of chain	:	Roller chain
Size of chain	:	DIN -16B-1
Total length, mm	:	711
Roller diameter, mm	:	16
Pitch length, mm	:	25.4

Tension adjustment	:	Yes, provided

3.1.1.3. Propeller Shaft

Type	:	Universal telescopic
Length	:	Variable, 675 (min), 885 (max)
Safety clutch, if any	:	Yes, provided

3.1.1.4. Gearbox

Gear box consists of a cubical cast iron casing each containing two miter gears mounted on the shafts perpendicular to each other. Two numbers of gear boxes are mounted one over the other and connected through a common shaft. This enables both the gear box to rotate relative to each other. The drive from the chain sprocket system is received by the bottom located gear box and transfers to top gear box. And the drive from the gear box is transferred to ditching and plastering unit. Bevel gear box used has 19 numbers of teeth on both driver and driven gears. Reduction ratio of power input shaft to crown gear power output shaft is 1:1.

Length of splines, mm	:	82
No. of splines	:	6
Oil capacity, l	:	0.400 (Each gear box)
Oil grade	:	SAE-85W140
Oil change period	:	After 100 workings hours
Method of driving	:	Driven by the output of the main chain drive unit
Details of chain		
Type of chain	:	Roller chain
Size of chain	:	DIN 16A-1
Total length, mm	:	1346
Roller Diameter, mm	:	16
Pitch length, mm	:	25.4
Tension control	:	Yes, provided

Drive for plastering disc

Type of drive	:	Chain & sprocket
No. of teeth on sprocket		
• Driver	:	10
• Driven	:	25
Speed reduction ratio from input shaft to output	:	1: 0.4

3.1.1.5. Ditching unit

Ditching unit consists of 5 pairs of blades with first pair differ from all the other. The sizes of the first pair blades are smaller than the others. The blades are mounted on the blade holders which are welded together with the drive transferring pipe. The guard cover is provided above the ditching blades, directs the thrown soil in convenient location for plastering.

3.1.1.6. Rotavator

A rotary tiller, also known as a rototiller, rotavator, rotary hoe, rotary plough, is a motorized cultivator that works on the soil by means of rotating tines or blades. The purpose of a rotavator is to break up the soil so that planting (either of crops or plants, mostly seeds) can take place. They do not dig deeply into the soil, but will turn the soil. The rotavator in the Ridge plastering machine consists of 10-tynes and attached to the tractor by means of a three-point hitch and driven by a power take off (PTO) shaft.

No. of blades	:	10
Type of blade	:	J-type blade (hatchet blade)
Effective diameter at the of smallest blade section, mm	:	245
Effective diameter at the of largest blade section, mm	:	602
Method of mounting	:	Blades are fitted on the blade holders which are welded on a pipe of dimension 40×60×370 mm.

Diameter, mm	:	40
Length, mm	:	180
Speed of the ditching rotor corresponding to the PTO speed 540 rpm	:	501

3.1.1.7. Plastering unit

It consists of a plastering disc and a forming roller as shown in fig 3.2 fitted on a common drive shaft of 40 mm diameter driven by a chain sprocket system. The soil thrown by the ditching unit at desire place is plastered and finishes the top portion of the ridge.

Fig 3.2 Plastering unit

Method of drive	:	Chain sprocket drive
No. of teeth on the driver sprocket	:	10
No. of teeth on the driven sprocket	:	25
Reduction ratio	:	0.4
Speed of the plastering disc corresponding to the tractor PTO speed 540 rpm	:	200

(a) Rotating disc

The purpose of rotating disc in the ridge plastering machine is to trim the bund and plaster it with pulverised soil so that the bund will be having a smooth finish with the help of roller attached to the disc. Plastering disc is formed by the trapezoidal plates fastened in a circular manner around a formed disc plate by placing the side edge of the trapezoidal plate over the other. The rotating disc is shown in fig 3.3.

Fig 3.3. Rotating disc

Effective diameter of the plastering disc, mm	:	683.0
Dimension of the plastering disc blade, mm		
A	:	65
B	:	200
H	:	270
Angle of inclination of the plate with the horizontal axis	:	60^0
Length of the chain, mm	:	1219

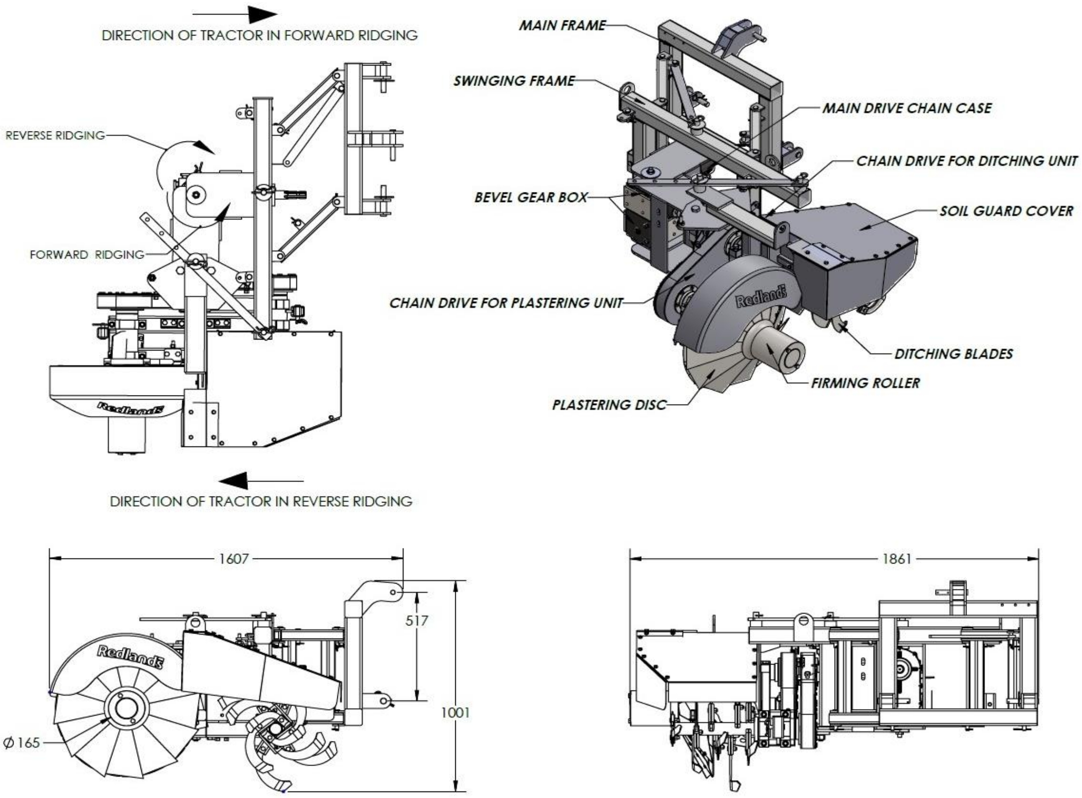
(b) Forming roller or Leveler

Forming roller as shown in fig 3.4. consists of cylindrical pipe mounted on the plastering unit drive shaft and it press firmly the top surface of the ridge. The purpose of forming roller in the ridge plastering machine is to prepare the irrigation plot in a way such that no high and or low spots disturb the uniform distribution of irrigation water on the field, and ensuring the optimal slope for water movement across a field when irrigated. Proper leveling leads to more efficient use of irrigation, fertigation and chemicals could be possible in the field. It also results in efficient soil aeration and water uptake by crops.

Fig 3.4. Forming Roller

Diameter of the forming roller, mm	:	167
Length of forming roller, mm	:	220
Control lever (If applicable)	:	Lowering and raising the implement is done with the hydraulic control lever of tractor
Lever for reverse ridging	:	Provided

The tractor operated ridge plastering machine is shown in fig 3.5.



All dimensions are in mm.

Fig 3.5. Tractor operated ridge plastering machine

3.1.2. Machine 2 – Yarrow Farms Ridge Plastering Machine

This is a tractor mounted PTO powered machine which can be operated by any tractor above 30 kW. During operation the machine receives the drive from tractor PTO through universal telescopic shaft which transfers power to the input shaft of primary gear box and power divided to both plastering disc and rotor disc by secondary gear box. The rotor disc unit attached with J shaped blades which ditches and throw the soil against the guard cover. The thrown soil is pressed against the bund wall and plasters side and top surface of the bund. The roller pipe presses the top land of the bund and plasters the top surface. Fig 3.6 shows the Yarrow Farms ridge plastering machine. Specifications are shown in table 3.2.

Fig 3.6. Yarrow Farms ridge plastering machine

3.1.2.1. Constructional Details

1. Three-point linkage

2. Gear box for rotary disc

3. Plastering disc

4. Ditching blade

5. Swing cylinder

6. Primary gear box

7. Gear box for plastering disc

8. Rotor disc

9. Plastering & ditching unit guard

10. Coulter disc

3.1.2.2. Propeller Shaft

Type	:	Universal telescopic
Length	:	Variable, 550 (min), 830 (max)
Safety clutch, if any	:	Yes, provided

Table 3.2. Specifications of Yarrow Farms ridge plastering machine

S. No	Particulars	Specifications
1	Purpose	For bund forming
2	Reverse ploughing	Not provided
3	Tractor power required, hp	Above 40 hp
4	PTO speed, rpm	540
5	Operating speed, km/h	0.5 to 1.7
6	Overall dimensions, (L x W x H), mm	2400 x 1100 x 935
7	No. of blades on roto tiller	6
8	Length of forming roller, mm	275
11	Weight, kg	360
12	Diameter of leveling roller, mm	133
12	Cost of the machine, Rs.	3,00,000/-

3.1.2.3. Power transmission system

Propeller shaft receives drive from tractor PTO and transmits the power to bund maker through primary & secondary gear boxes respectively.

(a) PRIMARY REDUCTION

It consists of input drive shaft and two idle gears, one driven gear, driven gear and output shaft.

Type of gear	: Spur
No. of teeth on drive gear	: 18
No. of teeth on idle gear	: 31
No. of teeth on driven gear	: 34
Reduction ratio at gearbox	: 1.88:1
Oil capacity, (l)	: 12
Grade of oil	: SAE 140

(b) SECONDARY REDUCTION

Drive for rotor disc

It takes drive from primary gear box by five numbers of spur gear and drive goes to rotor disc.

No. of gears	: 5
Type of gear	: Spur
No. of teeth on drive gear	: 11
No. of teeth on idle gear	: 21
No. of teeth on driven gear	: 19
Reduction ratio at gearbox	: 1.72:1
Oil capacity, (l)	: 6
Grade of oil	: SAE 140

Drive for plastering disc

It takes drive from primary gear box through a splined shaft with beveled pinion and drive goes to plastering disc by propeller shaft.

No. of gears	: 2
Type of gear	: Beveled
No. of teeth on drive gear	: 14
No. of teeth on driven gear	: 19

Reduction ratio at gearbox	: 1.35:1
Oil capacity, (l)	: 0.300
Grade of oil	: SAE 140

3.1.2.4. Ditching unit

Ditching unit consists of 4 pairs of blades (J-type blade) are mounted on the blade holder, which are welded together with rotor disc. The guard cover is provided above the ditching blades, directs the thrown soil in convenient location for plastering.

3.1.2.5. Plastering unit

It consists of a plastering disc and a forming roller fitted on a common drive shaft of 45.18 mm diameter driven by a gear drive system. The soil thrown by the ditching unit at desire place is plastered and finishes the top portion of the bund.

(a) Plastering disc

Plastering disc is formed by the trapezoidal plates fastened in a circular manner around a formed disc plate.

(b) Roller pipe

Roller pipe consists of cylindrical pipe mounted on the plastering unit drive shaft and it press firmly the top surface of the ridge.

3.2. INTRODUCTION TO POWER TILLER OPERATED RIDGE PLASTERING MACHINE

3.2.1. Power tiller

KAMCO KMB 200 power tiller as shown in fig 3.7 is manufactured by Kerala Agro Machinery Corporation Ltd., Athani, Ernakulam, Kerala. The test sample of power tiller was selected by the representative of Testing Authority through random selection. KAMCO Power Tiller is a versatile machine primarily used for preparation of land for farming operations. The technical specifications are shown in table 3.3. With suitably designed accessories, the machine can be used for a large number of specific operations like tilling, ploughing, weeding, pumping, puddling, levelling, hulling, ridging etc. It is designed to function in both wet and dry soil condition. It has retained its No. 1 position in the market in India over the last three decades.

Applications include tilling, ridging, pumping, spraying, threshing, puddling, weeding etc. Engine type i.e., ER 90 model is having characteristics that include single cylinder, horizontal, water-cooled, compression ignition type having rated speed of 2000 rpm. Gravity type of fuel feed system is present. Fuel tank have a capacity of 10.7 litres. Governor type is flyball type with a rated speed of 800 to 2125 rpm. Forced feed cum splash lubricating system is present. Clutch type is dry multi disc type.

Fig 3.7 KAMCO KMB 200 power tiller

Table 3.3. Technical specifications of KAMCO KMB 200 power tiller

Particulars	**Specifications**
Source of prime mover	Power tiller
Main power transmission	Rotary transmission (gearbox output shaft to rotary shaft)
Overall dimensions of the implement • Length, mm • Width, mm • Height, mm	 2450 940 1175
Gearbox Type	Sliding mesh
Engine type	Single cylinder, horizontal, water cooled, indirect injection, compression ignition engine.
Engine speed (rpm)	

• Maximum speed at no load • Rated speed • Speed at maximum torque	2100 ± 25 2000 1700
Power	9 hp (7 kW)
Cylinder • Number • Disposition • Bore/stroke (mm) • Stroke volume (cc) • Compression ratio • Type of combustion chamber • Type of cylinder liner	 1 Horizontal 95/105 744 19.6 : 1 Pre combustion chamber Wet, replaceable
Fuel system type	Gravity
Fuel tank capacity (l)	10.7
Fuel filters • Type of element • Number • Capacity of filter (l)	 Paper 1 0.500
Injection pump • Type • Method of drive	 Plunger Through cam shaft
Fuel injector • Type • Manufacturer's production pressure setting (kg. f/sq.cm)	 Pintle type 150 to 160
Governor • Type • Governed range of engine speed (rpm) • Rated engine speed (rpm)	 Mechanical, centrifugal 800 to 2125 2000

Pre-cleaner type	Cyclone with transparent dust collector
Air cleaner • Type • Oil capacity (l)	 Wet, oil bath 0.200
Exhaust • Type of silencer	 Updraft, cylindrical
Lubricating system • Type • Oil sump capacity (l) • Grade of oil used	 Force feed cum splash 3.0 SAE 40
Oil strainer • Type • Number	 Wire mesh magnetic filter at suction side of the engine 1
Pump • Type • Method of drive • Minimum permissible pressure (kgf/sq.cm)	 Lobe, trochoid type From cam shaft 2.50
Cooling system • Type • Details of fan • Bare radiator capacity (l) • Capacity of cooling system (l)	 Water cooled, thermosiphon with pressurized radiator pressure cap Suction type having 10 nos of metallic blades with a diameter of 180 mm 1 3.65
Starting system	Manual, hand cranking
Generator • Type	 Magneto

• Output rating	12 V /90 W
Lights • Number • Capacity	 2 12 V, 35/35 W
Belt - pulley (engine to clutch assembly) • Type • Number • Size of belts • Size of drive pulley (mm) • Size of driven pulley (mm) • Reduction ratio	 V belt and pulley 3 B – size 150 220 1.47:1
Clutch • Type • Diameter of discs (mm) • Number of friction plates • Method of operation	 Dry, Multi disc 175 3 By hand operator lever provided on RHS of handle bar
Gear drive (clutch to gear box) • Type • No. of teeth on drive gear • No. of teeth on idler gear • No. of teeth on driven gear • Reduction ratio	 Gear drive 17 33 32 1.88:1

3.2.2. Gearbox

KAMCO KMB 200 type model consists of sliding mesh type gearbox. Oil grade is SAE 90. Oil is changed first after 250 hours of operation then subsequently after 500 hours of operation. Number of speeds is 8 with 6 forward and 2 reverse. In the place of rotavator assembly, the auxillary gear box consists of two shafts, four bearings and a pair of spur gear sets, which meshes with each other in vertical position.

The main purpose of spur gear set is to reduce the speed and to supply required power to the ridge plastering unit. It also gets lubrication from the gear box oil of the power tiller. Engine is having a rated rpm from which the transmission takes place from gearbox output shaft to rotary shaft. Two combinations are 29-26 and 34-21 gear teeth for 315 rpm and 215 rpm respectively. The number of teeth on drive sprocket is 15 and on driven sprocket is 12. Thus, the speed reduction ratio is 1.25:1. Design considers the 215 rpm. The gear has a module value of 3 mm and a pitch circle diameter of 102 mm. Single drive shaft gets splitted for the design. There is dog clutch for engaging purpose.

3.2.2.1. Auxiliary gearbox

The auxiliary gearbox is used for transferring the power from main gearbox to rotary shaft. The auxiliary gearbox of KAMCO KMB 200 power tiller consists of the following components:

1. Rotary driving shaft
2. 29 teeth gear with pawl
3. 34 teeth gear with pawl
4. Collar for 29 teeth gear
5. 34 teeth gear bush
6. Dog clutch
7. 29 teeth gear bush
8. Collar 24 mm diameter
9. Collar 32 mm diameter
10. Ball bearing 6304
11. Ball bearing 6207
12. Oil seal 35 x 62 x 6

13. Stopper ring 32 mm diameter

3.2.2.2. Modifications on the auxiliary gearbox

- The 29 teeth gear (315 rpm) in the auxiliary gearbox was removed and the drive for operating the ridge plastering unit was taken from the remaining 34 teeth gear (215 rpm).
- Rotavator driving shaft running through the auxiliary gearbox was modified.
- Suitable length from its splined end was removed and it was replaced by another shaft.

Fig 3.8 shows the gearbox of power tiller after modifications.

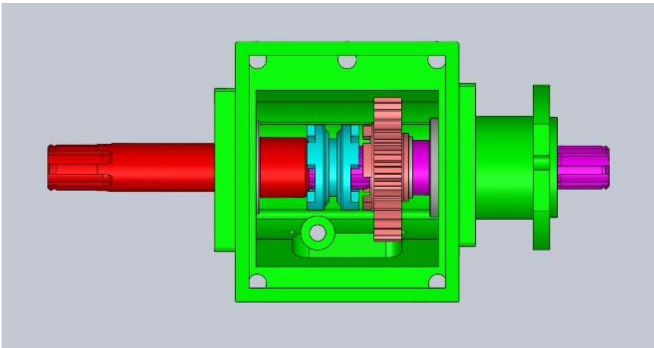


Fig 3.8. Gearbox of power tiller after modifications

3.2.3. Torque- power curve

An engine produces power by providing a rotating shaft which can exert a given amount of torque on a load at a given rpm. A torque/speed curve as shown in fig 3.9 plots the torque against the speed of engine. The amount of torque the engine can exert usually varies with rpm.

Typically, the torque peak will occur at a substantially lower rpm than the power peak. The reason is that, in general, the torque curve does not drop off (%-wise) as rapidly as the rpm is increasing (%-wise). Here in the design, for a power of 7 kW and rated speed of 2000 rpm, the torque was found to be 33.43 Nm. From the torque transmission curve, the speed corresponding to the maximum torque is 1700 rpm.

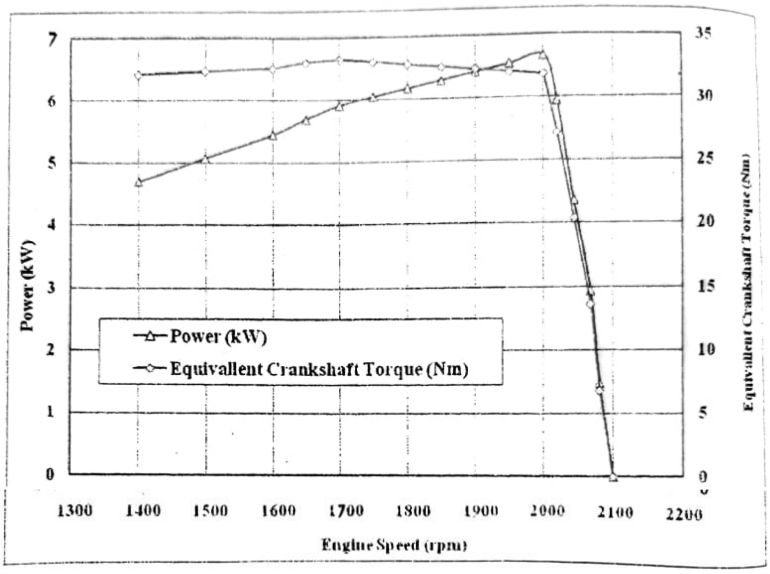


Fig 3.9. Torque – Power curve

The speed is reduced to 182.75 rpm and after the speed reduction on tooth basis, the speed is found out to be 146 rpm. While considering the 34-21 gear tooth combination, final speed value found to be 146 rpm and 236 rpm.

3.2.4. Design of gears

The fig 3.10 shows the 34 teeth gear.

Fig 3.10. 34 teeth gear

Step-1 Basic Selections

As per Appendix I

Step- 2 Number of teeth on Pinion (z_1) and Gear (z_2)

$$z_1 = \frac{2F_0}{sin^2 \propto}$$

Where, F_0= Height Factor= 1, for standard gear tooth

∝= Pressure angle = 20°

Step- 3 Calculation of Lewis Form Factor

$$Y = \pi \times y$$

$y = 0.154 - \frac{0.912}{z}$, for 20º involute

Step- 4 Material Selection

As per Appendix II

Step- 5 Determination of weaker member

For Pinion, $S_1 = \sigma_{b1} \times Y_1$

For Gear, $S_2 = \sigma_{b2} \times Y_2$

Member with lowest value obtained is considered to be the weaker member.

Step- 6 Design of weaker member

Criteria: - Design based on bending

Module,

$$m = 1.26 \sqrt[3]{\frac{[M_T]}{Y_1 \times \sigma_{b1} \times \varphi_m \times z_1}}$$

Power, $P = \frac{2\pi\, N_1 M_T}{60}$

Step- 7 Checking of contact stress

Criteria: - Design based on contact strength

Reduction ratio, i= 1.62

Centre distance, $a = \frac{m(z_1+z_2)}{2}$

Face width, b =10$\times m$

Young's modulus = E

$$\sigma_c = 0.74 \times \frac{i+1}{a}\sqrt{\frac{i+1}{i \times b} \times E \times M_T}$$

$\therefore$ Design is safe when contact stress $<$ crushing stress of material

Step- 8 Checking of dynamic load

F_s= $[\sigma_{b1}] \times b \times Y_1 \times m$

F_d= $F_T \times CV$

F_T=$\frac{2M_T}{d_1}$

where , $d_1 = m \times z_1$

CV= $\frac{5.5+ V_m^{1/2}}{5.5}$

Where, $V_m = \frac{\pi \times d_1 \times N_1}{60}$

$If\ F_s > F_d$ the design is safe for dynamic loading.

Step- 9 Checking for wear load

F_w=$d_1 \times Q \times b \times k$

$$Q = \frac{2 \times i}{i + 1}$$

$$k = \frac{\sigma_{c1}^2 \times \sin \propto \times \left\{\frac{1}{E_1} + \frac{1}{E_2}\right\}}{1.4}$$

Design is safe if $F_w > F_d$

Step- 10 Constructional Details

For pinion,

$$n_1 = 0.55 \times \sqrt[4]{P_c \times z_1^2}$$

$$P_c = \pi \times m$$

For gear,

$$n_2 = 0.55 \times \sqrt[4]{P_c \times z_2^2}$$

Type of gear is determined from the values from table related to n_1 and n_2

Step- 11 Design of Shafts

$$M_T = \frac{\pi}{16} \times d_{s1}^3 \times \tau$$

$$\frac{d_{s2}}{d_{s1}} = \sqrt[3]{i}$$

Reference is taken from PSG Design Databook for the design of gear.

3.2.5. Design of straight sided splined shaft & hub of the sprocket

A splined shaft (fig 3.11) is one that (usually) has equally spaced teeth around the circumference, which are most often parallel to the shaft's axis of rotation to prevent the relative motion between the drive transmission components. These teeth can be straight sided, included angle forms (serrations) or involute form. Here straight sided spline is selected for the design due to ease in manufacturing. Shaft-hub-connections are standard machine elements used to connect shafts and hubs. They are capable of transmitting torque, axial forces, radial forces and bending moments.

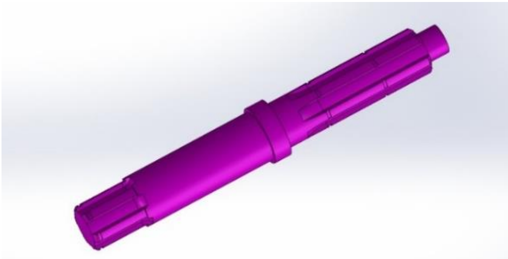


Fig 3.11 Straight sided splined shaft

The calculation includes adjustment for the operating conditions by including a service factor K_s. This factor is based on a design factor K_d, an application factor K_a, a load distribution factor K_m, a fatigue life factor K_f, and a wear life factor K_w. Based on compressive strength, resulting Compressive stress in spline σ_c (N/m^2).

$$\sigma_c = \frac{T.K_s}{n.d.Le.r}$$

Where,

r = Mean radius of spline (m)

n = Number of splines

Le = Effective Length of spline = Straight Length (m)

d = Depth of Spline (m)

T = Applied Torque (N.m)

K_s = Service factor

For a fixed /Guided spline,

$$K_s = \frac{K_a.K_d}{K_f}$$

K_s= Service factor

K_a= application factor

K_d = Design factor

K_f =fatigue life factor

τ = Resulting Shear stress in spline (N/m^2)

Shear stress in the reduced shaft diameter,

$$\tau = \frac{16.T.K_s}{\pi.D_i^3}$$

3.2.6. Design of shaft

The gear box of power tiller is connected to the chain drive of ridge plastering unit via a shaft. The rotary shaft (fig 3.12) is designed with considerations for the yield strength. Factor of safety is provided for its capability to bear heavy shock load. The ratio of yield shear strength to factor of safety provides the shear stress value. From torque and shear stress, the diameter of shaft is found out.

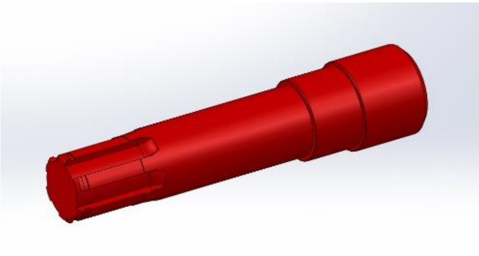


Fig 3.12. Shaft

Step- 1 Material selection

Step- 2 Calculation of yield shear strength

Yield shear strength = Yield strength x k

Step- 3 Calculate allowable shear stress

$$\text{Allowable shear stress} = \frac{\text{Yield shear stress}}{\text{FOS}}$$

Where, FOS = Factor of Safety

Step- 4 Determination of dynamic load

$$\mathrm{T} = \frac{\pi}{16} f_s d^3$$

Where,

T = Torque (Nm)

f_s = Allowable shear stress (MPa)

d = Diameter of shaft (mm)

Choose appropriate bearing according to the diameter of the shaft. Hence the dynamic load was determined.

3.2.6.1. Design of drive shaft support pipe

The chain drive is connected to plastering unit through another shaft. Ditching unit consists of a shaft with blade holders. Blades are attached to the shaft which helps in turning the soil. Plastering unit consist of plastering discs and forming roller. Increasing speed causes the torque to decline. Factor of safety is considered for proper design without failure. A factor of safety, also known as safety factor, expresses how much stronger a system is than it needs to be for an intended load. The drive shaft support pipe is shown in fig 3.13.

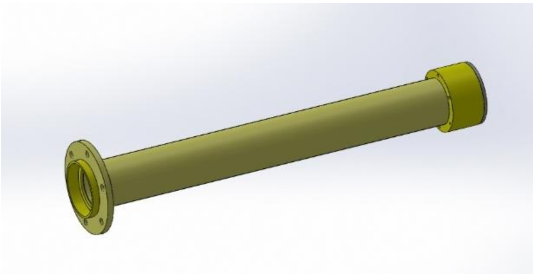


Fig 3.13. Drive shaft support pipe

3.2.7. Design of sprocket

Chain drive is a way of transmitting mechanical power from one place to another. A chain drive consists of a chain and two wheels, called sprockets. The sprockets are toothed wheels over which an endless chain is fitted. Most often, the power is conveyed by a roller chain, known as the drive chain or transmission chain, passing over a sprocket gear, with the teeth of the gear meshing with the holes in the links of the chain.

Torque acting on sprocket = load on sprocket x centre distance at which torque is acting

The dynamic load rating (C) is defined as the constant radial load that a group of apparently identical bearings will theoretically endure for a rating life of one million revolutions.

Design is safe when the load obtained corresponding to sprocket having greater torque is less than the dynamic load rating.

3.2.8. Chain drive case for plastering disc assembly and ditching unit

A straight slot shaped metal box of length 560 mm and width 160 mm is designed which can be welded and fabricated. The chain case of the ditching unit and plastering disc assembly is 60º and 5º inclined with the horizontal with respect to engine mounting position. Fig 3.14 shows the chain drive case.

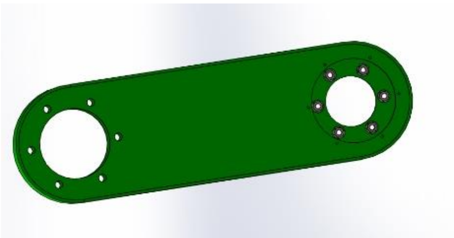


Fig 3.14. Chain drive case

3.2.9. Ditching unit

Ditching unit (fig 3.15) consists of 5 blades are mounted on the blade holder, which are welded together with rotor disc. Blade material is high carbon steel. The thickness of the blade is 6 mm and its length is 100 mm. The blades are twisted at an angle of 45º which cuts and throw the soil to the sides of ridges.

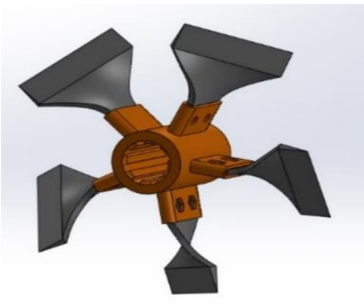


Fig 3.15. Ditching unit assembly

3.2.10. Plastering unit

It consists of a plastering disc (fig 3.16) and a forming roller (fig 3.17) fitted on a common drive shaft driven by a gear drivesystem. The soil thrown by the ditching unit at desire place is plastered and finishes the top portion of the bund. Plastering disc is formed by the trapezoidal plates fastened in a circular manner around a formed disc plate. The guard cover (fig 3.18) is provided above the plastering disc, directs the thrown soil in convenient location for plastering. The guard cover is made up of metal sheet of length 1375 mm which is bended and placed over the plastering disc.

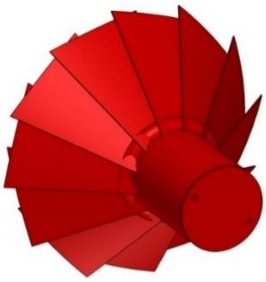


Fig 3.16. Plastering disc assembly

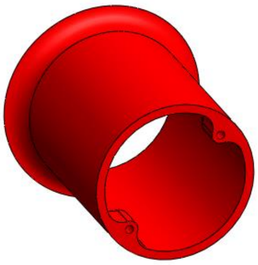


Fig 3.17. Forming roller

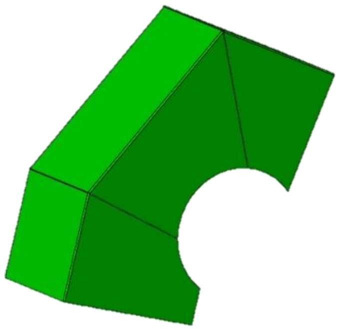


Fig 3.18. Guard cover

3.2.11. Structural Frame

Structural frame is made from square pipe of size 50x50x4 mm in which ditching unit and plastering unit assembly are rigidly fixed and the whole structured frame is mounted on the bottom portion of the gearbox of KAMCO power tiller.

3.3 SOLIDWORKS

SolidWorks is a solid modelling computer-aided design (CAD) and computer-aided engineering (CAE) computer program published by Dassault Systems, which runs primarily on Microsoft Windows. Solid Works Corporation was founded in December 1993 by Massachusetts Institute of Technology graduate Jon Hirschtick.

SolidWorks is a solid modeler, and utilizes a parametric feature-based approach which was initially developed by PTC (Creo/Pro-Engineer) to create models and assemblies. The software is written on Parasolid-kernel.

Parameters refer to constraints whose values determine the shape or geometry of the model or assembly. Parameters can be either numeric parameters, such as line lengths or circle diameters, or geometric parameters, such as tangent, parallel, concentric, horizontal or vertical, etc. Numeric parameters can be associated with each other through the use of relations, which allow them to capture design intent.

Design intent is how the creator of the part wants it to respond to changes and updates. For e.g., for having the hole at the top of a beverage can to stay at the top surface, regardless of the height or size of the can, SolidWorks allows the user to specify that the hole is a feature on the top surface, and will then honour their design intent no matter what height they later assign to the can.

Features refer to the building blocks of the part. They are the shapes and operations that construct the part. Shape-based features typically begin with a 2D or 3D sketch of shapes such as bosses, holes, slots, etc. This shape is then extruded to add or cut to remove material from the part. Operation-based features are not sketch-based, and include features such as fillets, chamfers, shells, applying draft to the faces of a part etc.

Building a model in SolidWorks usually starts with a 2D sketch (although 3D sketches are available for power users). The sketch consists of geometry such as points, lines, arcs, conics (except the hyperbola), and splines. Dimensions are added to the sketch to define the size and location of the geometry. Relations are used to define attributes such as tangency, parallelism, perpendicularity, and concentricity. The parametric nature of SolidWorks means that the dimensions and relations drive the geometry, not the other way around. The dimensions in the sketch can be controlled independently, or by relationships to other parameters inside or outside the sketch.

In an assembly, the an2alog to sketch relations are mates. Just as sketch relations define conditions such as tangency, parallelism, and concentricity with respect to sketch geometry, assembly mates define equivalent relations with respect to the individual parts or components, allowing the easy construction of assemblies. SolidWorks also includes additional advanced mating features such as gear and cam follower mates, which allow modeled gear assemblies to accurately reproduce the rotational movement of an actual gear train.

Finally, drawings can be created either from parts or assemblies. Views are automatically generated from the solid model, and notes, dimensions and tolerances can then be easily added to the drawing as needed. The drawing module includes most paper sizes and standards (ANSI, ISO, DIN, GOST, JIS, BSI and SAC).

3.3.1. Basic steps to design a model

When SOLIDWORKS initially starts, it'll be presented with the Welcome screen as in fig 3.19. This new dialog for SOLIDWORKS 2018 provides several tools for getting started, including buttons to begin a new part/assembly/drawing, browse for an existing document, open a recent document, or access recent folder or SOLIDWORKS resources.

To get started, click the Part button. This will open a new part document, and the rest of the user interface will be revealed.

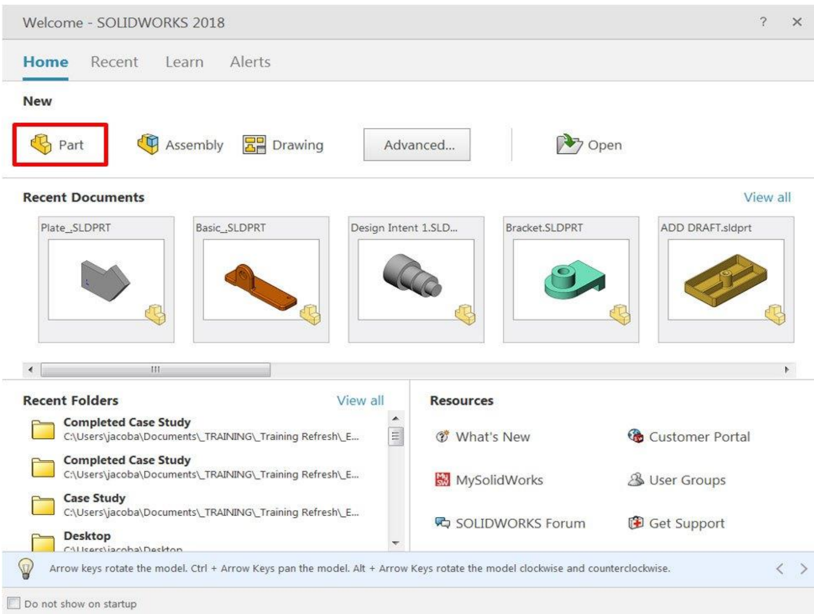


Fig 3.19. Welcome screen for SOLIDWORKS 2018

If there is no welcome screen, or are using an earlier version of SOLIDWORKS, click the New button on the standard toolbar at the top-left corner of the screen to open the New SOLIDWORKS Document dialog. From here, click the Part option and select OK.

3.3.2 Command Manager

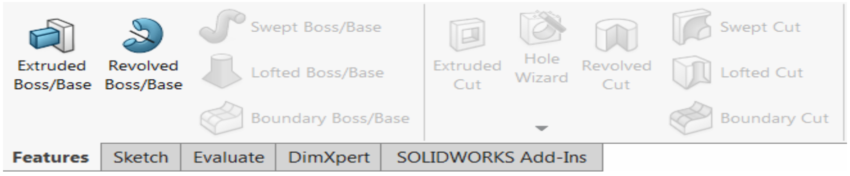


Fig 3.20. Command manager

The Command Manager (fig 3.20) is a context-sensitive toolbar that provides different sets of commands based on the tab that is selected directly below it (Features, Sketch, etc.). This is the primary area where users begin commands to create sketches, add/remove material, or evaluate models, among many others. In many cases, SOLIDWORKS will automatically switch to the appropriate Command Manager tab when changing modes, however, it may be necessary to manually switch between tabs by clicking on them.

It is possible to search for commands, provided if the name of the command is known as shown in fig 3.21. At the top-right of the interface exists a search bar, which by default allows the SOLIDWORKS help file to be searched. Click the down arrow on the right of the search bar and select Commands to enable command search. Search results can be clicked to execute the command, or the eyeball icon can be selected to automatically show the command's location in the user interface.

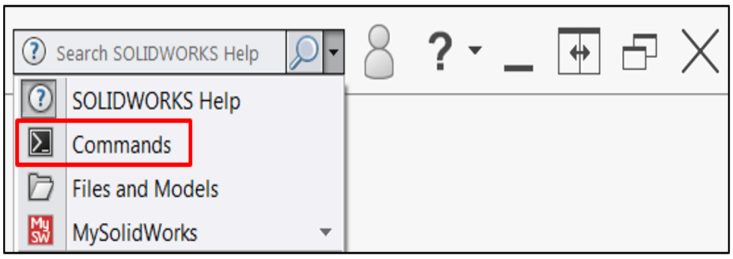


Fig 3.21. Searching for commands

3.3.3. Feature Manager Design Tree

The Feature Manager Design Tree (fig 3.22) is a chronological hierarchy of all the sketches and features that have been created or applied to the model, appearing just after the Origin. This section of the interface is exceptionally important, as it is where many editing operations originate.

This area of the user interface will temporarily change to a Property Manager when creating a new feature or during various other operations. This is the default behaviour of SOLIDWORKS, and the Feature Manager Design Tree will return once the feature has been completed.

The tabs at the top of the Design Tree are used to navigate to other interfaces that use the same space; if another interface is accidentally shown, simply click the first tab to return to the Design Tree.

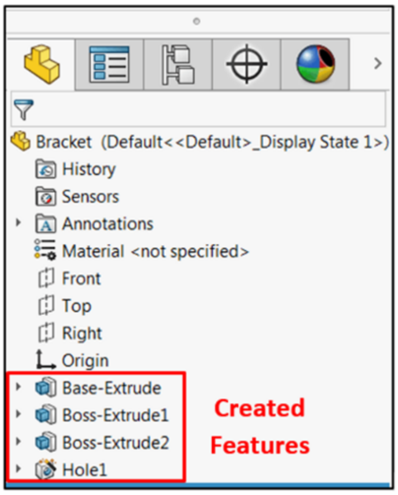


Fig 3.22. Feature Manager Design Tree

3.3.4. Heads Up View Toolbar

Fig 3.23. Heads up view toolbar

This transparent toolbar at the top of the graphics area provides a number of controls for manipulating the colors and appearances of designs as well as perspective of them as in fig 3.23. Commonly used functions here include fitting the model to the screen, changing view orientation, changing the display style (shaded with edges, wireframe, etc.) and applying colors/appearances to designs.

3.3.5. Task Pane

Fig 3.24. Task Pane

The Task Pane (fig 3.24) contains several tabs that all serve different purposes. While the Task Pane has a number of great tools within it, they are not required for basic use of SOLIDWORKS.

3.3.6. Graphics Area

This is the main area of the screen where models and drawings are viewed, controlled, and selected. Controlling model orientation/zoom and learning to properly select entities are critical to effectively designing with SOLIDWORKS. Left click an entity in the graphics area to select it. Alternatively, left click and drag the cursor to create a selection window. Right click on an entity to display a shortcut menu and a context menu, which contain a variety of commands applicable to the selected entity. The context menu is the smaller menu that appears with only icons; the shortcut menu is the larger menu that contains both icons and text. To rotate a model, click down on the center mouse wheel and drag the cursor. This will rotate the view freely in space, but does not change the coordinates of any geometry. If rotation is activated while hovering the cursor over existing geometry, that point will be fixed in space during rotation. To pan the view, hold the Ctrl key and follow the same steps.

Scroll the center mouse wheel to adjust the level of zoom in the model. By default, scrolling forward will zoom out, while scrolling backward will zoom in. This behavior can be reversed by changing the settings available in the View category of the System Options. For the best zoom performance, it is important to remember that when using the mouse wheel to zoom, the model will be zoomed in/out with respect to where the cursor is on the screen.

After looking at the key elements of the user interface to get acquainted with SOLIDWORKS, it gets off to a running start with the first model. Fig 3.25 shows the starting a new part document.

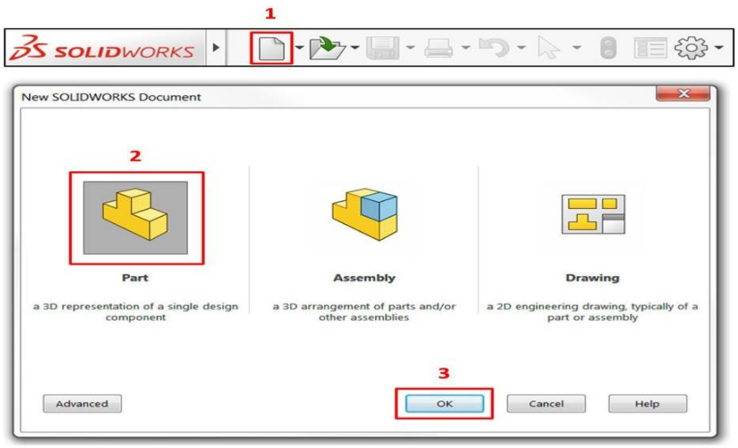


Fig. 3.25. Starting a new part document (SOLIDWORKS 2017 and earlier)

Once the new part document has been opened, the interface will look like the fig 3.26. There are six unique areas of the user interface which every new user should be familiar with.

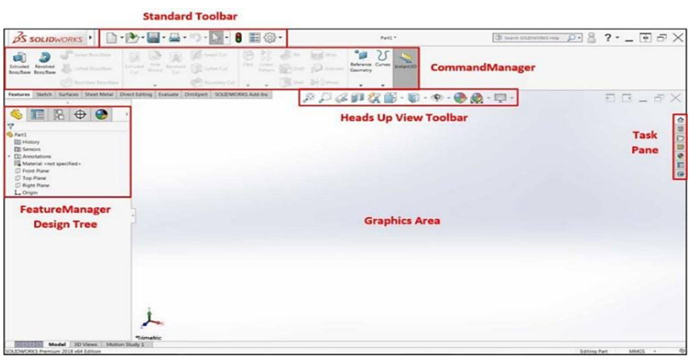


Fig 3.26. SOLIDWORKS user interface

3.3.7. Standard Toolbar

Fig 3.27. Standard tool bar

The Standard Toolbar (fig 3.27) contains basic commands including New Document, Open Document and Save Document. Additionally, at the right end of this toolbar, a gear icon is available which will open a System Options dialog, where a variety of settings can be changed.

CHAPTER IV

RESULTS AND DISCUSSIONS

This chapter contains the results and discussions of the designs done in order to fulfil the objectives of the present study. This deals with the design of several transmission components. Design of gear along with safety checked against several loads and stresses is explained. This also includes the detailed design of straight sided spline, shaft and sprocket.

4.1. GEAR DESIGN

Reference is taken from PSG Design Databook for the design of gear.

- Number of teeth on Pinion (z_1) and Gear (z_2)

$$z_1 = \frac{2F_0}{sin^2 \propto}$$

$$z_1 = \frac{2 \times 1}{sin^2 20} = 17.097$$

We have existing gear of teeth = 21

Reduction Ratio, $i = \frac{N_2}{N_1} = \frac{236}{146} = 1.62$

$\therefore z_2 = 1.62 \times 21 = 34.02 \approx 34$

Lewis form factor calculated by:

For Pinion, $Y_1 = \pi\left(0.154 - \frac{0.912}{21}\right) = 0.3471$

For Gear, $Y_2 = \pi\left(0.154 - \frac{0.912}{34}\right) = 0.3993$

Weakest member determination:

For Pinion, $S_1 = \sigma_{b1} \times Y_1 = 1100 \times 0.3471$

$= 381.81$ N/mm^2

For Gear, $S_2 = \sigma_{b2} \times Y_2 = 1100 \times 0.3993$

$= 439.23$ N/mm^2

- Checking of bending:

Power, $P = \frac{2\pi N_1 M_T}{60}$

$7 \times 10^3 = \frac{2\times\pi\times236\times M_T}{60}$

Torque, $[M_T] = 283390\ Nmm$

$\therefore module, m = 1.26\sqrt[3]{\frac{283390}{0.3471 \times 1100 \times 6 \times 21}}$

= 2.274 mm

Increasing 20% load, $m = 2.274 \times 1.2 = 2.73$ mm

Take standard m value as 3.0 mm

- Checking of contact stress

Reduction ratio, i= 1.62

Centre distance, $a = \frac{m(z_1+z_2)}{2} = \frac{3(21+34)}{2} = 82.5\ mm$

Face width, b =10$\times\ m = 10 \times 3 = 30\ mm$

Young's modulus, E= 2.10×10^5 N/mm^2

$$\sigma_c = 0.74 \times \frac{i+1}{a}\sqrt{\frac{i+1}{i \times b} \times E \times M_T}$$

$$= 0.74 \times \frac{1.62+1}{82.5}\sqrt{\frac{1.62+1}{1.62 \times 30} \times 2.10 \times 10^5 \times 283390}$$

$$= 1331.10\ < \sigma_c\ (1400\ \text{N}/mm^2)$$

∴ Design is safe.

- Checking of dynamic load

F_s= $[\sigma_{b1}] \times b \times Y_1 \times m$

=$1100 \times 30 \times 0.3471 \times 3$

= 34.362 kN

F_d= $F_T \times CV$

F_T=$\frac{2M_T}{d_1} = \frac{2\times283390}{63}$

where , $d_1 = m \times z_1 = 3 \times 21 = 63\ mm$

$CV = \frac{5.5 + V_m^{1/2}}{5.5} = \frac{5.5 + 0.778^{1/2}}{5.5}$

Where, $V_m = \frac{\pi \times d_1 \times N_1}{60} = \frac{3.14 \times 0.063 \times 236}{60} = 0.778\ m/s$

$F_d = \frac{2 \times 283390}{63} \times \frac{5.5 + 0.778^{1/2}}{5.5} = 10.439\ kN$

$F_s > F_d$

∴ Design is safe for dynamic loading.

- Checking for wear load

$F_w = d_1 \times Q \times b \times k$

$Q = \frac{2 \times i}{i+1} = \frac{2 \times 1.62}{1.62+1} = 1.24$

$$k = \frac{\sigma_{c1}^2 \times \sin \propto \times \left\{\frac{1}{E_1} + \frac{1}{E_2}\right\}}{1.4}$$

$$k = \frac{1400 \times \sin 20° \times \left\{\frac{1}{2.10 \times 10^5} + \frac{1}{2.10 \times 10^5}\right\}}{1.4}$$

k= 4.56 N/mm^2

$F_w = 63 \times \frac{2 \times 1.62}{1.62+1} \times 30 \times 4.56 = 10658.5\ N$

= 10.66 kN $> F_d$

So, Design is safe.

- Constructional Details

For pinion,

$n_1 = 0.55 \times \sqrt[4]{P_c \times z_1^2}$

$P_c = \pi \times m = 3.14 \times 3 = 0.942\ mm$

$z_1 = 21$

$\therefore n_1 = 0.55 \times \sqrt[4]{0.942 \times 21^2} = 2.48$

For gear,

$n_2 = 0.55 \times \sqrt[4]{P_c \times z_2^2}$

z_2= 34

$\therefore n_2 = 0.55 \times \sqrt[4]{0.942 \times 34^2} = 3.159$

From the Appendix III, pinion will be integral type and gear will be solid type.

- Design of Shafts

$M_T = \frac{\pi}{16} \times d_{s1}^3 \times \tau$

τ= 70 N/mm^2

M_T= 283390 Nmm

$\therefore 283390 = \frac{\pi}{16} \times d_{s1}^3 \times 70$

$d_{s1} = 27.42\ mm$

Take standard value for d_{s1} as 28 mm.

$\frac{d_{s2}}{d_{s1}} = \sqrt[3]{i} = \sqrt[3]{1.62}$

$\therefore d_{s2} = 28 \times 1.2 = 33.6\ mm$

Take standard value for d_{s2} as 34 mm.

- Summarization

  Summarization of gear design is shown in table 4.1.

Table 4.1. Summarization of gear design

Sl. No.	Nomenclature	Notation	Value
1	Module	m	3 mm
2	Centre distance	a	82.5 mm
3	No. of teeth on pinion	z_1	21

4	No. of teeth on gear	z_2	34
5	Width of gear	b	30 mm
6	Height factor	f	1
7	Diameter of input shaft	d_{s1}	28 mm
8	Diameter of output shaft	d_{s2}	34 mm

4.2. DESIGN OF STRAIGHT SIDED SPLINE

Reference IS -2327:1993 Straight Sided Splines for cylindrical shaft dimension with internal centring Dimensions and Tolerances and Verification.

A standard straight sided spline of medium series spline of size 6 × 28 × 34 is selected. (IS -2327:1993)

The material selected for the shaft is EN-24 with case hardened with the following specifications:

Tensile strength =1100 MPa

Shear strength, S_S= 634 MPa

Compressive strength, S_C = 324 MPa

Outer most diameter = 34 mm

Reduced diameter, D_i = 28 mm

Width of the spline, B=7 mm

No. of Spline, N= 6

Length of spline selected, L_e: = 36 mm

Mean radius of the spline, r= (28+34)/4 = 15.5mm

Resulting effective depth of the teeth (y) = (D- D_i)/2 = (34-28)/2 =3 mm

K_a= 2.4 (Medium shock for internal combustion engine)

K_d = 1 (Closed fit loaded)

K_f =1.0 (No. of start/ stop cycles= 10000)

For a fixed /Guided spline,

$$K_s = \frac{K_a.K_d}{K_f}$$

$$K_s = \frac{2.4\ x\ 1}{1.0} = 2.4$$

The shear stress in the reduced shaft diameter (D_i),

$$\tau = \frac{16.T.K_s}{\pi.D_i^3}$$

$$\tau = \frac{16 \times 283.39 \times 4.8}{\pi\ \times\ 28^3}$$

= 157.875 MPa

Factor of Safety = $\frac{S_s}{\tau}$ = $\frac{634}{157.875}$ ~ 4.0

The compressive stress in the spline and the shaft,

$$\sigma_c = \frac{\mathrm{T.K_s}}{\mathrm{Le.n.r.y}}$$

$$\sigma_c = \frac{283.39 \times 4.8}{36 \times 6 \times 15.5 \times 3}$$

= 135.43 MPa

Factor of Safety = $\frac{S_c}{\sigma_c}$ = $\frac{324}{135.43}$ = 2.239

So, the design is safe.

4.3. DESIGN OF SHAFT

Assuming the shaft is subjected to twisting moment only and neglecting bending moment.

EN 24 is the shaft material

Yield strength = 1100 MPa

Yield shear strength = Yield strength x k

= 1100 x 0.6

= 660 MPa

Assume FOS = 8

Allowable shear stress,

$$f_s = \frac{660}{8}$$

$$= 82.5 \text{ MPa}$$

Torque

$$T = \frac{\pi}{16} f_s d^3$$

$$283390 = \frac{\pi}{16} \text{ x } 82.5 \text{ x } d^3$$

$$d^3 = 17503.34$$

$$d = 25.96 \text{ mm}$$

After bending moment considerations, the diameter of shaft is taken as 30mm.

So, bearing selected = 6006

The dynamic loading capacity of bearing 6006 is 13.2 kN.

Reference PSG Design Databook for the design of shaft.

4.4. DESIGN OF PLASTERING UNIT SHAFT

The chain drive is connected to plastering unit through another shaft. Ditching unit consists of a shaft with blade holders. Blades are attached to the shaft which helps in turning the soil. Plastering unit consist of plastering discs and forming roller. As the gear tooth reduction happens from 15 to 12, the speed increases at the end of plastering unit shaft. Increasing speed causes the torque to decline. Therefore, the same dimensions can be selected for the plastering shaft i.e., inner diameter as 28 mm and outer diameter as 34 mm. Factor of safety is considered for proper design without failure. A factor of safety, also known as safety factor, expresses how much stronger a system is than it needs to be for an intended load.

4.5. DESIGN OF SPROCKET

Power = 7 kW

Rpm at maximum torque condition= 1700 rpm

Selected chain drive = 12 B-1

Number of teeth on drive sprocket = 15

Number of teeth on driven sprocket = 12

Torque = force × distance

For 12 teeth sprocket,

226712 = load x 36.86

Load = 6150.62 N = 615 kgf

For 15 teeth sprocket,

283390 = load x 45.87

Load = 6178.1N = 617.8 kgf

According to PSG Design Databook the braking load corresponding to 12 B-1 is 2950 kgf.

As 617.8 kgf < 2950 kgf, the design is safe.

Factor of safety = 2950/617.8 = 4.77

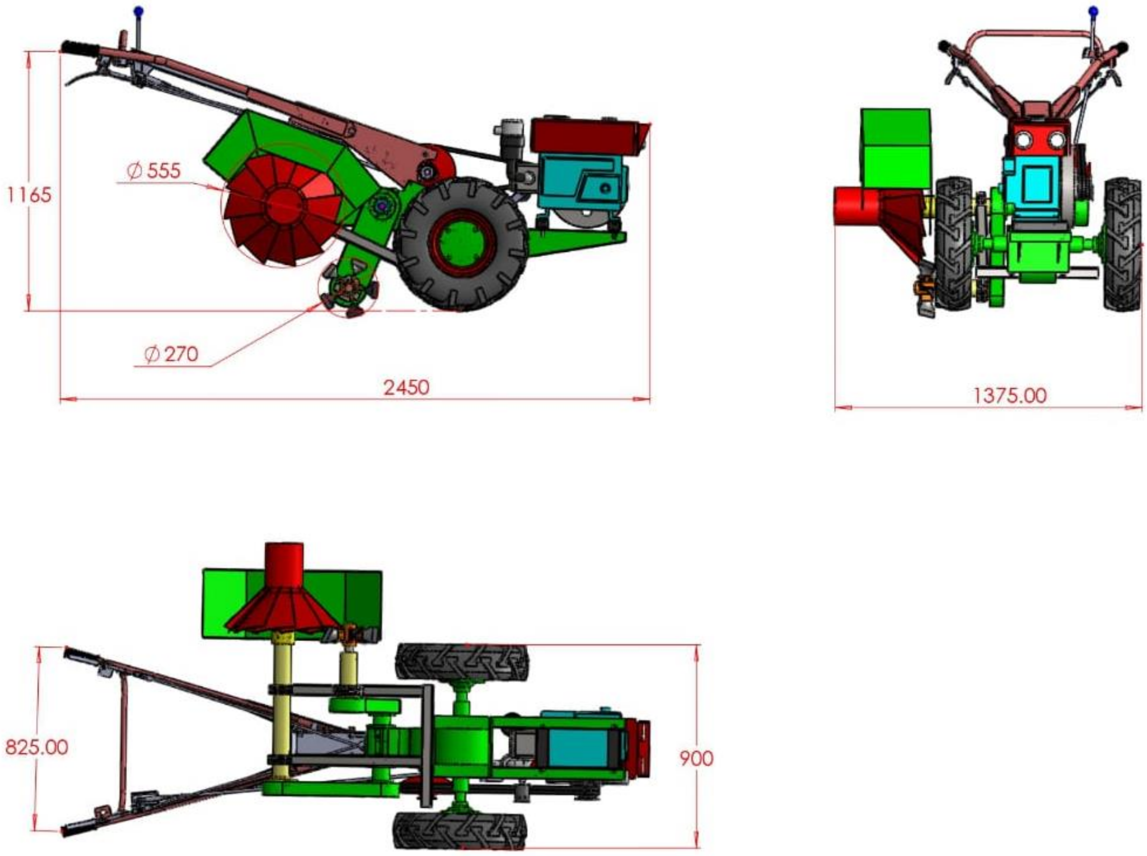
For 6006 bearings,

Dynamic load rating = 13200 N

Thus, it can bear a load of 617.8 kgf which is less than 1320 kgf.

Therefore, 6006 bearing is selected i.e., 30 mm diameter.

Fig.4.1 shows the two-dimensional drawing of power tiller attached ridge plastering machine.



All dimensions are in mm.

Fig.4.1. Two-dimensional drawing of power tiller attached ridge plastering machine

4.6. WORKING PRINCIPLE

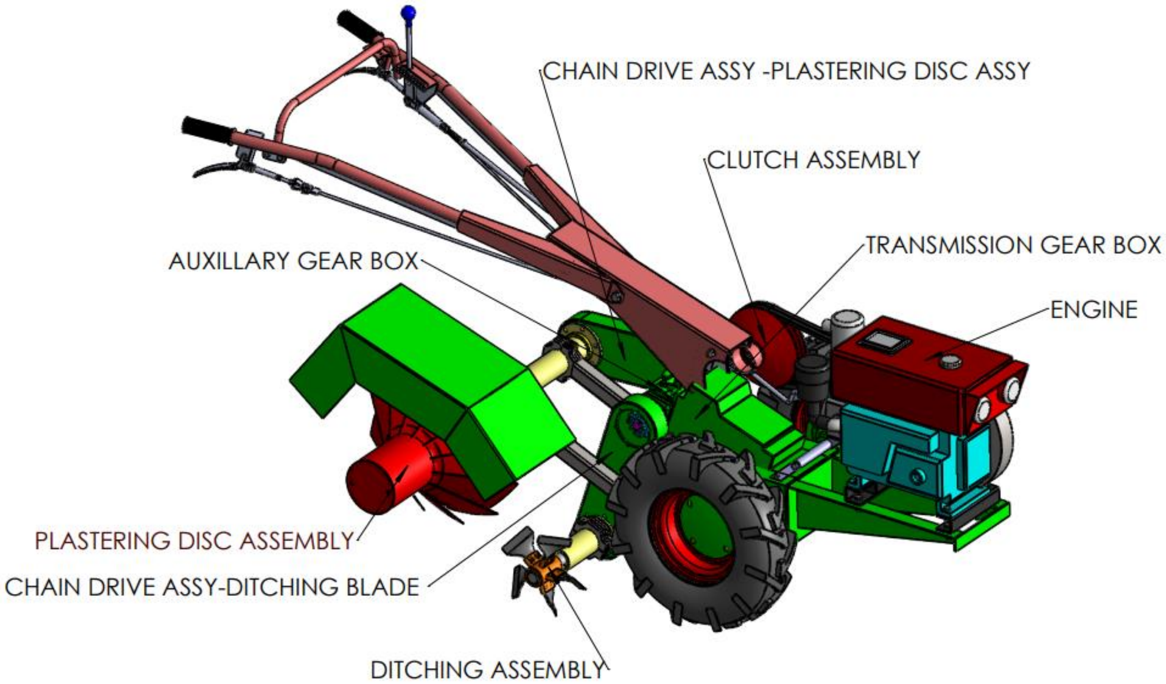


Fig 4.2. Power tiller attached with ridge plastering attachment

The power tiller attached ridge plastering assembly consists of the auxillary gearbox, plastering disc unit, ditching unit and chain drive assembly as in fig 4.2. The attachment receives the main power from gearbox output shaft to rotary shaft. The power is transmitted to plastering disc assembly and ditching unit through different chain drive assemblies. The rotary ditching attachment cuts the soil from the ground and throw against the disc assembly cover which drops the thrown soil over the plastering disc assembly. The plates arranged on the conical disc plasters the side wall of the bunds and the forming roller compacts the top of the ridge.

CHAPTER V

SUMMARY AND CONCLUSIONS

Modern agricultural techniques and equipments are not used by small land holders because these equipments are too expensive and difficult to acquire. By adopting scientific farming methods, we can get maximum yield and good quality crops which can be save a farmer from going bankrupt. But majority of farmers still use primitive method of farming techniques due to lack of knowledge or lack of investment for utilizing modern equipments. This has the disadvantage of low efficiency, low strength and high cost. The tractors and powertillers are easily available for the farmers to carry out almost all the tillage operations like ploughing, puddling, levelling as well as transportation.

The mechanization of the bund making process is one of the important tasks to be done to achieve sustainability in paddy cultivation. The rodents can be controlled by this machine due to its effective trimming, plastering and compaction. The introduction of tractor operated ridge plastering machine reduces the drudgery and cost of operation. But the combined weight of tractor and ridge plastering machine results in the sinkage of the tractor in the puddle field. A change from tractor operated to power tiller operated ridge plastering equipment made a simple, effective, indigenous and cost effective one. The machine will be utilised for both dry and wet conditions. It reduces the cost of operation, increases the affordability and also suitable for small land preparations.

The parts of ridge plastering machine suitable for the power tiller were designed using SOLID WORKS software. The critical components of the attachment like shafts, gears, sprockets, bearing splines etc. are analytically calculated. The ridge plastering attachment consists of bund plastering disc assembly, ditching unit and a modified auxiliary gear box of the KAMCO power tiller. The 29 teeth gear (315 rpm) in the auxiliary gearbox was removed and the drive for operating the ridge plastering unit was taken from the remaining 34 teeth gear (215 rpm). The rotavator driving shaft running through the auxiliary gearbox was modified. Suitable length from its splined end was removed and it was replaced by another shaft.

The blades of the ditching unit on the periphery of the circular disc cut the soil and throw against the disc assembly cover; the rotating disc trims the bund and plasters it with thrown soil. The roller attached to the rotating disc compresses the soil. The unit is designed in such a way that it can form a new ridge of height 20 cm and a renovated ridge up to 40cm. The machine can be operated with 9-12 hp range power tillers.

CHAPTER IV

REFERENCES

Fakruddin, S.K.B. 2018. Development of bund trimming and plastering equipment for rice fields. M. Tech. (Ag) thesis, Acharya N. G. Ranga Agricultural University, Andhra Pradesh.

Huang, H. C., Liu, C. W., Chen, S. K., and Chen, J. S. 2003. Analysis of percolation and seepage through paddy bunds. *J. of Hydrol*. 284: 13-25.

IS -2327:1993. Straight Sided Splines for cylindrical shaft dimension with internal centring Dimensions and Tolerances and Verification, *Indian Standards*.

Kawahata, N., Ono, H., Kamashita, Y., Hamano, T., and Nagaoka, E. 2008. Application of a three-dimensional reconstruction method to analysis of residual ridge. *J. of Oral Rehabil.* 24(12): 936-941.

Lewis, D. C., Scott, V. H., Muller, K. V., Viste, K. L., Babb, A. F., and Fox, D. R. 1962. Plastic rice leeves. *Calif. Agric*. 16(3): 8-10.

Pathirana, P. H. S., Bandara, P. C., Ratnaweera, A.C., Balasooriya, C. P., and Bandara, M. A. 2010. Sustainable farming through mechanization: Development of a bund making machine. *International Conference on Sustainable Built Environment*; 13-14, December, 2010, Kandy. University of Peradiana, Sri Lanka, p.461.

PSG College of Technology 1966. *Design: Databook of engineers*. PSG College of Technology, Coimbatore.

Rahul, A., Prashant, G., and Rajaiah, P. 2018. Performance evaluation of tractor operated ridge plastering machine. *Int. J. of Chem. Stud.* 8(5): 45-48.

Rajaiah, P., Laxman, B., Vennela, B., and Reddy, A. P. 2020. Development and evaluation of mini tractor operated ridge plastering machine. *Int. J. of Chem. Stud.* 8(5): 45-48.

Ryals, L. E. 1984. Rice leeve shaker and packer. United States Patent No. 4438819. Available: https://patents.google.com/patent/US4438819A/en [27 March 1984].

Sharma, P. C. and Aggarwal, D. K. 1997. *Machine Design.* Katson Publishing House, New Delhi, 234p.

Singh, S. P., Solanki, R. C., Singh, M. K., and Singh, K. 2016. Development of tractor operated bund former-cum-packer for increasing resource productivity. *Indian J. of Agric. Sci.* 86(9): 1121-1126.

APPENDIX- I

Sl. No.	Parameters	Options	Selections	Justification
1	Tooth Profile	Cycloidal/ Involute	Involute	Easy to cut and pressure angle remains constant.
2	Pressure Angle	14.5/ 20/ 25	20º	Compromise between cost and size of entire gearbox, commonly used.
3	Type of Tooth	Full depth/ Stub tooth	Full depth	Power transmission is smooth.
4	Quality of cut	Commercially cut/ Carefully cut/ Precision cut	Precision Cut	To avoid pitting failure and dynamic loading.
5	Type of system	Open/ Closed	Closed	To prevent abrasive wear.
6	Type of gearing	Corrected/ Non corrected	Non corrected	Easy to design and interchangeable.
7	Gear box Layout	Symmetrical/ Unsymmetrical	Symmetrical	Compact and less costly.

APPENDIX- II

Elements	**Material**	**Bending Stress (σ_b)**	**Crushing Stress (σ_c)**
Pinion	SAE 8620, Case Hardened	1100 N/mm^2	1400 N/mm^2
Gear	SAE 8620, Case Hardened	1100 N/mm^2	1400 N/mm^2

APPENDIX - III

Value of n	**Type of gear**
n ≤ 3	Integral Type
n ≤ 4	Solid Type
n ≤ 5	Web Type
n > 5	Arm Type

d (mm)	**No. of arms**
d < 500	4
d < 1500	6
d < 2400	8
d > 2400	10

DESIGN OF RIDGE PLASTERING ATTACHMENT FOR POWER TILLER

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ABSTRACT

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IN

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Faculty of Agricultural Engineering and Technology

Kerala Agricultural University

DEPARTMENT OF FARM MACHINERY AND POWER ENGINEERING

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ABSTRACT

The decreasing rural population is becoming increasingly responsible for feeding the growing urban population; increase in productivity of agriculture has become an essential feature in stepping towards sustainability. As younger generation show reluctance in opting farming as occupation agriculture faces huge shortage in labour especially in Kerala. But agricultural mechanization has a vital role to motivate the young people to enter in farming sector. Ridge forming is a vital operation involved in the rice cultivation which demands huge labour force. The traditional manual ridge making and plastering is characterized by low efficiency, low strength, high cost and directly affects the profitability of paddy cultivation. The introduction of tractor (35-45hp) operated ridge plastering machine has alleviated the drudgery involved in bund forming operation of labours and considerably reduced the cost of operation. But the combined weight of tractor and ridge plastering machine results in sinkage of the tractor in the water-logged paddy fields and the affordability of separate machine for plastering. Keeping this in view the present study includes the familiarization of engine and transmission system of power tiller and the methodology involved in the operation of different tractor operated ridge plastering machines and also designed a ridge plastering attachment for power tiller. The power tiller selected for the study is KAMCO KB 200. The different parameters of engine and transmission system of KAMCO KB 200 are studied for the design of ridge plastering attachment. Different tractor operated ridge plastering machines of Redlands, Yarrow Farms etc are analyzed. 3D model of the ridge plastering attachment along with the power tiller is developed. The critical components of the attachment like shafts, gears, sprockets, bearing splines etc. are analytically calculated. The ridge plastering attachment consists of bund plastering disc assembly, ditching unit and a modified auxiliary gear box of the KAMCO power tiller. The blades of the ditching unit on the periphery of the circular disc cut the soil and throw against the disc assembly cover; the rotating disc trims the bund and plasters it with thrown soil. The roller attached to the rotating disc compresses the soil. The unit is designed in such a way that it can form a new ridge of height 20 cm and a renovated ridge of up to 40 cm.