# Design and Modeling of Portable & Safe Chaff Cutter Machine

Thesis report

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# DEDICATIONS

I dedicate my MSc work to my parents and numerous companions. An extraordinary sentiment appreciation to my loving guardians, whose uplifting statements and push for determination ring in my ears. My family has never left me alone and are extremely outstanding. I additionally dedicate this thesis to my many family members and friends who have endorsed me all through the procedure. I will dependably value all they have done.

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**"He, who is not thankful to the people, is not thankful to Allah".**

After that, I am indebted to all those who helped me in any form at any stage of my work.

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# ABSTRACT

Agriculture is consider to be backbone of Pakistani economy, it is estimated that 19.5% of Gross Development Product employing a large quantity of the workforce to provide raw materials for many regions of value-added. Hence it plays a tremendous role in national development, security of food and shortage alleviation. Instantaneous progress in city areas in Pakistan depicts that the need for important fresh products such as fruits, vegetables, dairy products, and the meat is increasing.

In this research work, the utility model reveals a portable and safe chaff cutter machine which consists of a feed channel, a pair of feed roller, one shear blade, three cutting blades, a discharge channel, an electric motor, power transmission unit, an idler frame and a casing. Electric motor transmits power to the shaft of cutting blades and these blades act tangentially to the shear blade. The upper feed roller shaft transmits power to lower feed roller shaft through spur gears. These spur gears mesh and generate opposite rotation to each other and this rotation helps the chaff to move forward. The utility model has the advantage of good automatic feed effect, reduces the number of workers, lightens labor intensity, improves the efficiency, avoids personal injuries, and short crops and long crops can be all fed simultaneously.

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# Chapter 1

# INTRODUCTION

## 1.1 Background

Pakistan being an agricultural region, it is analyzed that 21% of GDP is based on this sector.(Pakistan Economic Survey, 2009-10). By 2011, the country's approximated residents was 0.177 billion including 96 million men and 86 million women (Pakistan bureau of statistics, 2011). 64% compared with the urban population, the population lives in rural areas (PIN, 2011). Agriculture is the biggest employer in the country, 45% of the country's population is employed. Animal husbandry in 2009-2010, agricultural added value accounted for 53.2% of GDP and 11.4% of GDP. From 2003 to 2010, the average growth rate of the livestock industry was 5%. The main products of livestock are milk and meat. Plant Disease Diagnostics Clinic (2006) proves 65% of overall milk Production from Punjab, Sindh includes 26% and 11% from Khyber Pakhtunkhwa (formerly the North West Frontier Province) 2% of Balochistan. Pakistan is located in arid subtropical regions, with much of the country in a semi-arid climate. In the 1980s, Pakistan was divided into 10 agro ecological zones based on topographic and climatic parameters. Diversity: (I) Indus Delta; (ii) Southern Plains Irrigation; (iii) Desert; (IV) Northern Irrigation Plains; (v) Barany Area (rain); (VI) wet mountains; (viii) western arid mountains; (ix) western dry shelves; and (x) Suleiman Piedmont.

Agriculture is consider to be backbone of Pakistani economy, it is estimated that 19.5% of Gross Development Product employing a large quantity of the workforce to provide raw materials for many regions of value-added. Hence it plays a tremendous role in national development, security of food and shortage alleviation. Instantaneous progress in city areas in Pakistan depicts that the need for important fresh products such as fruits, vegetables, dairy products, and the meat is increasing. The supervision is working to rise the output of village areas through large groundwork Investments include reliable transportation linkages and other building chunks for current chains of supply. China–Pakistan Economic Corridor Through the use of value-added product innovation, we will make great progress in improving the efficiency of agricultural enterprises. National Population Institute (NIPS) said that 1,132,800 people live in rural areas of the country. It is predicted that the country herd includes 0.356 billion cows, 0.317 billion buffaloes, and 28.1 heads, millions of sheep, 0.615 billion goats, 0.1 billion camels, 0.47 billion donkeys, 400,000 horses and 200,000 Scorpion. Animal rearing is an important aspect of animal husbandry. [1]

Regular resources include feed Crops, range grasses, including shrubs and weeds, beet tops, sugar cane tops, silage and leaves. The Feed cutting machine (local language card machine) is one of the most commonly used agricultural machinery on the farm. It is mainly used to cut the feed into small pieces, which is important for animal digestion system. The cutting process is carried out by cutting the rotating blade in front of the blade. The agricultural sector is increasingly being affected by global environmental and social changes (Tilman et al., 2002). The challenges of food production and the risk of food insecurity are growing because population of the world is anticipated to be approximately 9 billion by 2050 (FAO, 2014b, Fischer et al. 2014). In addition, uncertain weather conditions are expected to lead to a decline in production in developing countries (IPCC, 2014). It is estimated that about 10% of agricultural productivity The capacity of developing countries will decline in 2080 due to global warming (Cline, 2007 The In particular, small farmers from Asia and Africa may face the challenge of food production (God fray et al., 2010). Most rural farmers in these areas have fallen into poverty and food difficulties Insecurity due to low yields and lack of adequate food access (FAO, 2015). A way to deal with these challenges facing agriculture and the uncertainty facing the future are to improve farmers' ability to innovate has given them the ability to improve agricultural production. Recent debate on strengthening the ability to innovate has received wide attention from various scholars and researchers, multilateral and bilateral development stakeholders.[2]

### 1.1.1 Performance during the years 2016-17

2016-17 performance, the performance growth of the agricultural industry and sector has not yet reached the expected target and achieved 3.46% growth; while the set figure is about 3.5% of the previous year performance growth rate was 0.26 percentages. Better harvesting of major crops through increased access to agricultural inputs like water, agricultural credit and intensive fertilizer purchases leads to betterment of farmer. Animal husbandry accounts for 58.33%

agriculture as equated with percentage of 3.36% in the same period of time last year and it increased by 3.43% this year. The contribution of the fisheries sector to agricultural value added is 2.12% and has increased 1.23%, compared with 3.25% in the equal time period previous year. The sector of forestry has contributed 2.34 percent of the agricultural growth increased significantly by 14.49% in 2016-17 The timber production reported by Khyber Pakhtunkhwa increased. [2] (Table 2.1) Agricultural growth percentage: Significance of the agricultural field: the agricultural industry and sector always plays a vital role in economy of any country like Pakistan. Agriculture in Pakistan is largest sector which provide employment to the 48% people in the country and contribute as a second biggest sector contributing about more than 21 percent of GDP. In Pakistan, about 62 percent of the total population of the country lives in dwelling in rural areas and is associated to agriculture in any way either directly or indirectly. Close links between agricultural industry and sector and other economic sectors most of the times are not depicted in the estimation of statistics. If we consider its importance on the one side, the agriculture is a main supplier of downstream industrial raw materials and made a significant contribution to overall export of Pakistan. On the other hand, it is a big market and user for most of the industrial products such as pesticides, fertilizers, agricultural equipment, tractors and machinery [3]. In Pakistan agriculture is one of the main occupations of the country, and discovery and implementation are very necessary. Despite a lot of work in this area, there are new ideas in this area. Unfortunately, these ideas are all not implemented properly in the real world. This is due to the high cost and complexity of the rural population.[3]

Table 1.1 *Agriculture Growth Percentage*

| Sector | 2010-11 | 2011-12 | 2012-13 | 2013-14 | 2014-15 | 2015-16 | 2016-17 (P) |
|---|---|---|---|---|---|---|---|
| **Agriculture** | **1.96** | **3.62** | **2.68** | **2.50** | **2.13** | **0.27** | **3.46** |
| Crops | 0.99 | 3.22 | 1.53 | 2.64 | 0.16 | -4.97 | 3.02 |
| i) Important Crops | 1.50 | 7.87 | 0.17 | 7.22 | -1.62 | -5.47 | 4.12 |
| ii) Other Crops | 2.27 | -7.52 | 5.58 | -5.71 | 2.51 | 0.59 | 0.21 |
| iii) Cotton Ginning | -8.48 | 13.83 | -2.90 | -1.33 | 7.24 | -22.12 | 5.59 |
| Livestock | 3.39 | 3.99 | 3.45 | 2.48 | 3.99 | 3.36 | 3.43 |
| Forestry | 4.76 | 1.79 | 6.58 | 1.88 | -12.45 | 14.31 | 14.49 |
| Fishing | -15.20 | 3.77 | 0.65 | 0.98 | 5.75 | 3.25 | 1.23 |

Source: Pakistan Bureau of Statistics
P: Provisional

Multi-purpose agricultural machinery is the largest foundation and main equipment for agriculture yield. The conventional method of growing and growing crops is a laborious process, so is the same reason for the scarcity of the labor force has led to the delay in overcoming these difficulties designed with multifunctional agricultural equipment. The project aims to help small-scale food growers by designing a chaff cutter; the demand for a variety of locally grown cereals is increased. According to PRB (2010), Pakistan makes its place at the sixth in the list of most populous countries in the world. The population estimation (2012) pointed out that there are about 118 million people who live in the rural areas or villages of the country. They are directly or indirectly contacted with the agricultural or agricultural industry.[4]

Table 1.2. Numbers of cattle's by household

| **Number of Cattle** | **% of ownership by household** |
|---|---|
| 1-2 | 27.32 |
| 3-4 | 23.73 |
| 5-6 | 14.32 |
| 7-10 | 13.68 |
| 11-15 | 6.29 |
| 16-20 | 2.66 |
| 21-30 | 2.58 |
| 31-50 | 2.71 |
| 50 and above | 6.72 |
| Total | 100 |

The sector of agricultural is still a promoter for rural economy of the country. Almost all people in the country rare the cattle and thus Pakistan has a large population of livestock. A sensible estimation of national herd includes about 35.7 million head of cattle, 31.71 million of buffalo, 61.50 million head goats, about 28.10 million head of sheep, and 1.0 Millions of camels, 4.70 million donkeys, 400,000 horses and 200,000 cows (Pakistan Economic Survey, 2010-11). The table below 2004-2011 lists the growth trends in agriculture and its sub-sectors.[5]

Table 1.3 Pakistan Agriculture sector growth in percentage

| Year | Agriculture | Major Crop | Minor Crops | Livestock | Fishery | Forestry |
|---|---|---|---|---|---|---|
| 2004-05 | 6.5 | 17.7 | 1.5 | 2.3 | 0.6 | -32.4 |
| 2005-06 | 6.3 | -3.9 | 0.4 | 15.8 | 20.8 | -1.1 |
| 2006-07 | 4.1 | 7.7 | -1.0 | 2.8 | 15.4 | -5.1 |
| 2007-08 | 1.0 | -6.4 | 10.9 | 4.2 | 9.2 | -13.0 |
| 2008-09 | 4.0 | 7.8 | -1.2 | 3.1 | 2.3 | -3.0 |
| 2009-10 | 0.6 | -2.4 | -7.8 | 4.3 | 1.4 | 2.2 |
| 2010-11(P) | 1.2 | -4.0 | 4.8 | 3.7 | 1.9 | -0.4 |

## 1.2 Need of Project

Major part of economy of a country is based on agriculture because most of the industry is based on the agriculture or assisted by it. Scope of mechanization in agriculture is very wide as it improves the production, reduces time and hence the overall productivity is enhanced. It is very unfortunate that the farmer cannot bear the expenses to hold all kind of agricultural machinery at one place himself and Chaff cutter machines is one of them. Thus keeping this in view, a small but very efficient multipurpose chaff cutter machine is designed which is not only cheap but more accessible also. It is safe to operate, reduces labour and time to cut the forage. Machine is not complex; maintenance is easy and works under all conditions.[6]

## 1.3 Problem Statement

Existing models of manually and power operated chaff cutter machines cause injuries. Moreover, statically and dynamically unbalanced model causes more noise and no more portable. More number of gears used in system lead to more consumption of electric power. The cutting blades used in existing chaff cutter machines have curve shape and required to be sharped after 15-20 days. All these problems give some idea that what we required and what we are trying to design in the present scenario. Motive is to develop an efficient machine which is not only economical but also safe to use. [7]This machine is cost effective and easy to maintain and repair for the farmers. Most of the dairy farmer are using medium-sized chaff cutter machine which are large in size, less efficient and require much lubrication and maintenance all the time; even they are not safe for operator and many accidents have been noticed when people working on the machine lost their fingers or hands. It is a need of the hour to design a portable and safe chaff cutter machine for dairy farms.[8]

Table 1.4 Small versus large scale farmers

| | Marginal Farmers | Small Farmers | Big Farmers |
|---|---|---|---|
| Land Holding | Up to 1 ha | 1-2 ha | Over 10 ha |
| Proportion of all Farmers | 75% | 10% | 0.24% |
| Share of Land Owned | 30% | 24% | 6% |
| Avg Monthly Income | Up to 5247 | 7348 | 41388 |
| Avg Monthly Expenditure | Up to 6020 | 6457 | 14447 |
| Avg Investment in Productive Assets | Up to 540 | 422 | 6987 |
| Avg Savings / Deficit | ₹ 1500 | ₹469 | ₹1994 |

## 1.4 Objectives

This machine will help small scale farmers for easy operation and less manual work. This will help them to save time and money. It will also help to increase productivity and make more profits. This will make them to use new technology in agriculture. To design a small multipurpose chaff cutter machine for the farmer is our goal. A very cost effective and efficient design of the machine is under consideration. Reduction of maintenance and repair cost is also one of the considerations. No stone is left unturned to make it safe and reduce the injuries. In short all the steps to make ease in the process are considered.[9] Our goals and aims are as under:

- Saving the storage area

- Save electricity consumption
- Efficient and fine cutting of fodder and avoid wastage and spoiling of fodder
- Assist easy mixing of supplements
- Compact design with ensured safety
- Provision of good fodder for cattle

Design modification of chaff cutter to enhance safety and reduce fatigue of workers.It contains the following advantages:

- To minimize work time
- Reduction of electricity consumption
- To provide pleasing/aesthetic look
- To get protection from dust
- Noise reduction
- To increase corrosion resistance of machine

## 1.5 Expected outcome

This machine will help small scale farmers for easy operation and less manual work. This will help them to save time and money. It will also help to increase productivity and make more profits.[10] This will make them to use new technology in agriculture.

# Chapter 2

## LITERATURE REVIEW

Background via nationwide, most of the food we eat is produced by large agricultural supply chains. Connect farmers, seed suppliers, pesticide and fertilizer suppliers, transporters, distributors, Wholesalers and retail stores. Currently, the US harvest is about 114.8 million acres. The annual food value is about $15 billion (US Department of Agriculture Agricultural Census, 2007). In some sizes this scale of production is not sustainable. One of the problems is $28 billion. All farms in the United States are spent on chemical fertilizers, mainly composed of chemical fertilizers. [11]

Non-renewable resources including fossil fuels (US Department of Agriculture 2007 Agricultural Census) and although these Small-scale grain harvesters exist in parts of Europe and Asia, and farmers do not import such machine entered the United States because the transportation cost was too high. To harvest veins, Small farms either rent combine harvesters or use hand tools such as sickles or sickles (Pitzer, 2010). Neither of these technologies is suitable for small-scale food production. Combine Harvesters are too large and cumbersome for this scale and are almost impossible Maneuvering in urban agricultural environments. Hand tools may be less than half an acre, but if there are multiple small plots of land, it will be a very laborious and time consuming task. What is needed is a machine of the appropriate size that can be used by farmers to cut fodder. We interviewed small-scale growers and agricultural engineers to identify current issues planting cereals in New England to understand the types of machines currently used for harvesting Grains and develop appropriate design standards for our products. Once we designed one with the 3D computer model, we worked with the trio review team to refine our ideas. Through this design, we hope to provide farmers with a way to cut grass more efficiently. In a broad sense, the development of cities and small-scale agriculture, machine design we designed cutting all aspects of agricultural silage. We determined that this design satisfies most of our parameters. We have already specified it. Ideally, other designers will look at our model and determine the plan Manufacture our designs. After that, the prototype will be built and tested to determine if a prototype issues exists that need resolving.[3] After several iterations, we hope that the mower can Sold on the market.

- **Seth Tufail** made a chaff cutter consisting of an S-shaped flywheel Speaking of a flywheel with two cutting blades installed; these cutting blades work Axial to the shear plate.
- **Song et al.** people studied the blade of a cylindrical mower Machines and they use open and tough blades. Both sides of the blade are Sawtooth.
- **Zhao** designed the S-shaped mower with fast cutting speed and high efficiency. This design has a symmetrical inverted S-shaped blade mounted through a central bore. This design is very good and the service life is safe due to the fixed design parameters.

- **Tian Gang** outlined a versatile hay cutter machine having high cutting rate and less work cost. These cutters were liable to impressive wear amid activity, caused by the crop and pollutions contained in that, for example, sand.[12]

## 2.1 Needs of chaff cutting

Animal feeding is imperative part of livestock farming. It is extremely important to have successful use of accessible feed sources. Teasing grains and straws to little pieces and after that feeding to animals enhances the Digestibility, palatability of feed and conserve energy that they need to use in rumination. Moreover, teasing lessens wastage of feed assets, and is viewed as a perfect innovation worth receiving by farmers. With the quick improvement of livestock husbandry in our nation, the search business is growing by leaps and bounds; the green feed and coarse grain possess a critical place among the scavenge.[4]

- **Bhargrave** revealed that the un-slashed straw would give final decision for the animals to specifically expend more edible parts and abandoning the less edible parts, which subsequently prompts generous feed wastage. What's more the animals may need to spend more energy for chewing the un-slashed straw, than the chopped straw.
- **Dikshit and Birthal** evaluated the rate of feed conversion in different animals species in different groups at the national level, taken together by type, function and ability, nature and interest Feed continuous foods by 2020. According to this study, it will be in India by 2020 Take 8 million green chicken and 56 focus Animal feed (including 27.4 metric grains, 4.0 mm pulses, 20.6 metallic oils, oilcake, etc.) Feed and prepared feed 3.6 Mt). Depending on the nutrients it has a translation of 738 MW. In the dry time, the total nutrients include 379 Mt and 32 Mt pools of crude protein. Estimating the interest for different feeds will

help the decision makers of the countries. Commercial planning plan to increase the profits from animal production.

- **Tiwari and Kumar** studied that fodder chopping is done for the most part to spare storage room, to help in relieving to make the feed more palatable, to encourage uniform blending of concentrates and furthermore to keep the fodder free form spoiling while in storage. The machines utilized for chopping fodder are called chaff cutter or ensilage cutter or storehouse filler.[13]

## 2.2 Accident with chaff cutter:

There is a wound of immunity in the witch at different levels. Children may face the following due to:

- Door net accidents like at home are harmful due to the accident casing rails, glass wounds etc.
- Accidents in agricultural fodder cutting machines etc..
- Accidents in traffic**[14]**

- **Jinnah Hospital** Lahore highlighted momentous number of agriculture machine injuries and Toka injuries were at the top of list. They received 74 patients from Jan 2009 to Oct 2012. They examined that most frequently involved age group was 4 years to 45 years. The upper limb is the most generally injured section. Out of these 47 patients mandatory Microsurgical Intervention. Mainstream of the Microsurgical Work was replantation.
- **Shaikh Zayad Hospital, Rahim Yar** Khan testified the hazard of using Toka Machine and in this study 73 patients affected by power-driven Toka Machine. The injury were occurred during 15 months period in 2014 - 2015. Out of these 32 were male and 41 were females. All patients sustained injuries to the upper limbs. Left limb was involved in 38% (28) patients and right upper limb was involved in 56% (41) patients and 5% (4) patients have bilateral upper limb injuries.
- **Riffat** got thirty-three patients who were treated with relevant wounds from agriculture 9 Nelsel Chad Cutter (Toka) is the most common agricultural equipment 51.5% (17) are involved in cases. Triumphant immigration of unusual or large-surface upper material death 57.7% (19) cases were the most common pain in cases.

- **Sir Ganga Ram Hospital,** India, tested 28 patients over a period of 3 years, the fingers or hand pulled out through the chicken cutter to the customer of which eight patients were lost to follow. 80% of the 20 patients (16) were boys and 20% (4) girls were there. Most children came from Harriana, Punjab and North Regions of U-Pradesh.
- **Rawal** understood that in Punjab it is related to human factors in these 73% of cases, the implementation of agriculture is included in this regard. They lose clothes, physical work in more work and skills.
- **Kumar and Anjali** reported that the chaff cutter caused increased by 7.8 percent in the accident. Wear-related wear parts (8% of total accidents) were ineffective in nature from the cashew Lack, security and design conformity of the local artists on site. Quality is unusual for use in rural areas. Analysis emphasizes effective safety and health management.
- **Mohan** said fodder cutter machines were used by Farmers and their families in India for the preparation of a charity to feed the cattle Self. An extensive study in northern India shows that all ages are maintained. Chaff cutter causes the wounds while running the machine.
- A comprehensive study of wounds and machine features comes in a safe way cutter design fluctuation apply effectively and can be included in both Current and new Chaff cutters. This paper has confirmed this process the community-based study and the safe design of Chaff cutter machine.
- **Kumar** took a survey of Ghaziabad district in five villages of Uttar Pradesh North State of India) to determine the challenges that are responsible for chaff cutters. This It was seen that the masses are injured when the children run the machines and Worker, during chaff feeding the fodder in machine outcome and observing. This mechanism of the injured, there are three safety precautions that are designed to stop Experiments were made using different four crops to be injured during the operation Demonstrate a problem with fat intake using protective interfaces. It was felt about safety there was no effect on interrupting the trick-cutting process. These were the results In other places, retired on old machines and we look at positive reactions[13].

## 2.3 Chaff cutter performance

Yadav noticed that parameters of strength play an important role in designing of manually operated push-pull type equipment. Both hands average strength in standing posture for male and female workers was noticed to be 209.93 and 117.72 N-m respectively. Strength of torque preferred hand in the sitting posture and torque of hand grip worked out in studying for both male and female workers were seen very well in designing of hand controls such as steering, knobs, etc. These strength parameters play an important role in design/ modification of hand controls and foot controls on workplaces of different machines. The workplaces of machine designed on strength parameter data were noticed to greatly uplift the operator's comfort, safety and efficiency also.

- **Zakiuddin and Modak** produced experimental data-based system ANN model on the basis of human or manually powered Chaff chopper. The experimentation was done on fodder chopper powered by the human power. ANN module was developed to produce the correct value of result parameters related to various values of the input parameters. The produced ANN can be used to give the best value of different independent features for the design of chaff cutter to match the machine feature by doing the chaff cutting task so as productivity should be maximum and torque and cutting time should be minimum.
- **Khope and Modak** developed a study on the design of experimental setup Experimental relationship related to the power cutter cutter by human power Fly-Ville Motor. Accordingly, using this point of view and found it working on a graphic cutter create experimental relationships for human-powered chop-cutting operations to her. Man was systematically, for him it is tough and incredible to take the overall theory of view Such design, experimental approach was taken. This set up has three subscribers
    - Human Powerful Flower Motor (HPFM) - Energy Unit.
    - Increase the talk Gears and Clutch Unit and
    - Processing Unit IA Chef Cutter..[13]
- **Dr. J. C. Kumarappa** produce shape to Gandhian concept for Rural Economy. In this case study it is seen that many human powered machines are produced at MGIRI and CVS that can be modified by applying Human powered flywheel motor concept that is similar to recently mechanical polisher produced which run with human powered flywheel motor (S.M.Moghe,K.S.Zakiuddin) at Nagpur university Maharashtra, India.1hp motor run it.

This polishing machine is manually operated. Traditionally polishing is done by hand polishing and labors that rub any finger on very hard surface or push them below the feet wrapping in the big bags where damage risks are more.[15]

## 2.4 Chaff cutter machine

Chaff Cutter Machine is applied to cut into a small piece of feeding animals (Mohan D and Kumar A, 2004); This is a better feeding, clean and clean And well with aerial and fresh pieces with small pieces, sand and dust Dirt chef can be purchased from commercial chaff cutting mills (Wikipedia, 2009] The cutting chaff can be done manually by the machine and electrical operation is done Traditionally, for most of the operators are manually done by physically demanding energy It is regarded as the needs of the plants and the general problem of concern (Kumar P, Eth 2004). Many farmers linked to this work reported back, shoulders and wrists. This Possibly due to clinical or anthropological illnesses and can affect the health of the worker[16].

A Chaff cutter is a mechanical device which is used to cut small pieces for strap or grass cutting mix it together and feed the cattle. It improves the animal cord and prevents the animal disposal of any part of your feed. Now one day view is the population of the Bhutan Increased too much. Therefore, to increase the productivity and reduce the physical effort It is best to have motorized machines available to run the machine For dairy farmers. At that time, four cutting machines are hand-held with electricity operation or engine runner[17]

## 2.5 Types of chaff cutter

On the basis of power source used for its operation, chaff cutters are classified as manually operated and power operated.

### 2.5.1 Manually operated hand chaff cutter:

This type of chaff cutter is very common with the farmers and is operated manually by one or two persons. Another person is required to feed the crop to the cutting mechanism. In general, the speed of the flywheel having single blade is 50 rpm whereas with two blades the speed is 35 rpm. This type of chaff cutters have curved blade and are used cutting of comparatively small quantity of the fodder. In order to cut large quantity of the fodder, a hand chaff cutter is operated by either a stationary diesel engine or a small electric motor. It is very popular in rural areas for cutting of the fodder crops into smaller pieces, locally referred as Toka (cut hey) for daily need of the animals. It is also known as flywheel type chaff cutter machine.

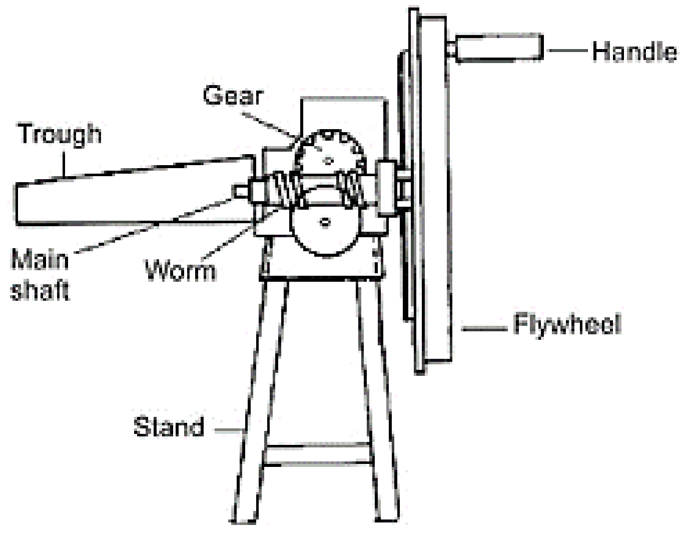



Fig. 2.1 Manually Operated hand chaff cutter:

### 2.5.2 Power operated chaff cutter:

A power chaff cutter may utilize comparatively a large size electric motor or stationary diesel engine for its operation. The speed of cutting head ranges between 600-1000 rpm. Generally, a power chaff cutter utilizes straight blades, fitted radially on a heavy flywheel, instead of curved blades. The rim width of the flywheel is made little wider or a separate pulley is attached on the main shaft of the flywheel for transmitting power of the prime mover to the flywheel through flat belt. The speed of the flywheel is kept between 200-250 rpm. The capacity of this type of chaff cutter is about 250-300 kg/h (with 1 hp electric motor) or 1000-1500 kg/h (with 2 hp electric motor). The length of cut of the fodder varies between 9.5 to 16 mm. A minimum of two persons are required to feed the crop when operating with electric motor. The clearance between the blade and shear plate is kept 1.5 mm.[18]

Fig. 2.2 Power operated chaff cutter

On the basis of cutting mechanism, the chaff cutter should be one of the following types: Fly wheel type and Cylinder type.

### 2.5.3 Fly wheel type:

A chaff cutter is having rotating flywheel with blades. The flywheel is made of cast iron or steel for the purpose of mounting blades and storing energy for cutting the chaff during operation. The flywheel should be heavy and balanced for cutting of chaff with efficiency. A flywheel of 900 mm to 1350 mm diameter shall be provided. The flywheel shall have two arms. Each arm shall be provided with one square hole for fixing the handle; three holes for fixing the blade and six tapped holes for fixing the bolts for blade setting adjustment. At the center of the flywheel, a circular hole shall be provided for connecting it to the main shaft. A hole of 10 mm diameter shall be made in the rim of the flywheel parallel to the direction of the hub hole. The weight of the flywheel shall not be less than 24 kg.

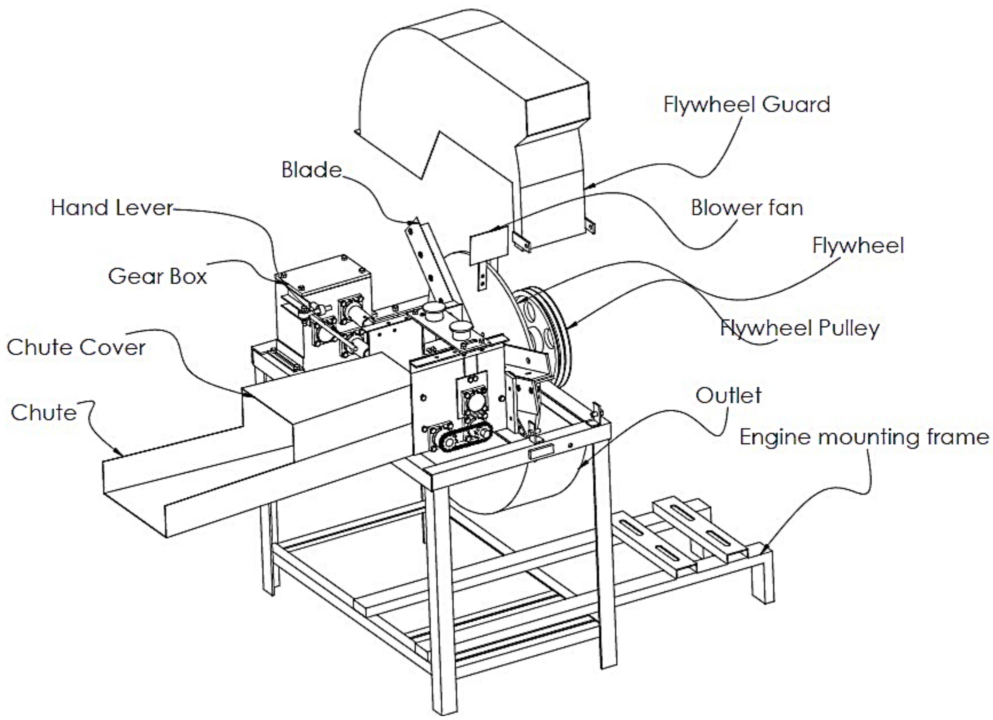



Fig. 2.3 Fly wheel type chaff cutter

### 2.5.4 Cylinder type:

Cutting of a chaff cutter is a mechanism in which it rotates cutting cylinder. The chart kit will be provided with Linux with Linux Chuff hard core faille when it does not need to run will be set to it finally the fast key gear shaft to limit system movement. This is the place Since 13 the chaff per cutter is essential to avoid bladder movement Due to wounds due to accident rotation, when the chuff cutter is not in use. Lunch will be With China's fastest food fast food tea. A bolt will also be installed Strong with a hole in the whole (leg holes and flywheel rim).


Fig. 2.4 Cylinder type Chaff cutter

The chaff cutter has given types on the basis of its dropping positions

### 2.5.5 Let fall type:

Its that type in which the cut fodder is dropped down to the bottom of the chaff cutter.It should be selected randomly from the production series by the representing person of the testing authority with manufacturer's consent. It must be manufacturer's responsibility to determine that the chaff cutter designated for testing is complete in all respects and necessary modifications have been conceded out in the presence of testing authority represented.[19]

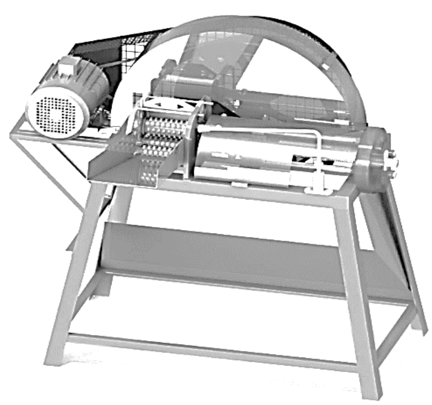


Fig. 2.5 Let fall type Chaff Cutter

### 2.5.6 Throw way type:

In this type the cut fodder is thrown away to the front ward of the chaff cutter. Handle must consist of handle support made of mild steel rod and a wooden grip placed over the rod. The handle support's diameter must be maximum value of 15 mm. The maximum length of the handle must be at minimum 510 mm and the length of wood grip must be between 420-450 mm. The diameter of the grip must be 37 mm-42 mm. The grip must be properly attached with the support, and one end of the support has to be threaded. The handle has to be attached with fly wheel by the hexagonal nut with washers.[20]


Fig. 2.6. Throw way type Chaff Cutter

### 2.5.7 Blow up type:

In this type the cut fodder is blown up through the blow-up pipe. A flywheel of 900 mm-1350 mm diameter should be provided. The flywheel has to have two arms. Each arm shall be provided with a square hole for fixing the handle; three holes for fixing the blade and six tapped holes for fixing the bolts, for blade adjustment. A circular hole shall be provided for connecting it to the main shaft at the centre of the flywheel. A hole of 10 mm diameter must be made in the rim of the flywheel parallel to direction of the hub hole. The total mass of the flywheel must not be lesser than 24.0 kg. It works on 5 HP-7.5 HP electrical motor or diesel engine. Output ranges from 2500 to 3000 kg per hour & RPM required for this purpose is 550-600. Before starting the machine, fill the main gear box with the 250 ml lubricating oil the outer gear box with 100 ml lubricating oil & grease Always keep the blade sharp .Sugarcane, jowar, maize Barseen both dry and green can be chaffed. Conveyor system can be fitted by demand. The mouth of mach is grinding on an automatic grinding machine.[21]

Fig. 2.7 Blow up type Chaff Cutter

Chapter 3

# MATERIAL AND METHODS

## 3.1 Material choice:

The suitable option of the material for variant attachments of machine is the major goal in manufacturing of machines. For a designer it is necessary to have an understanding of the impacts how the properties of materials behave during fabrication and heat treatment processes. Material selection is based upon the particulars given below:

- Material Accessibility
- Working constraints
- Cost
- Chemical and physical attributes of material

### 3.1.1 Mechanical properties

The understanding of materials and its attributes has gravity for designer. The components of machine must be assigned a material which could with stand the operating condition. Moreover, he should know the impact of heat treatment and manufacturing process on the part to be manufactured. In designing the machine part he should know how the material will behave in working conditions. These mechanical properties and characteristics are mainly determined by the standard tensile tests.[22] A machine component can be under following forces

- Torque or Energy Transmitted
- Dead weight
- Resistance
- Thermal forces
- Imbalance between parts
- Inertial forces

The material choice is dependent upon the type of stresses which can develop in machine during working. It also depends on the loads acting on machine as machine can withstand a static loading more easily than a dynamic loading and a dynamic loading more easily than shock loading. Another aspect limiting our choice for material selection is safety factor or fraction of safety which in further depends on the following important factors[23]:

- Applied load certainty
- Certainty in mode of failure
- Reliability of characteristics
- The extent to which assumptions are made
- Localization
- Initial stress developed in manufacturing process

## 3.2 Modeling of chaff cutter machine:

Modeling is done in AutoCAD 3D and the name of every component is given alongside with diagram.

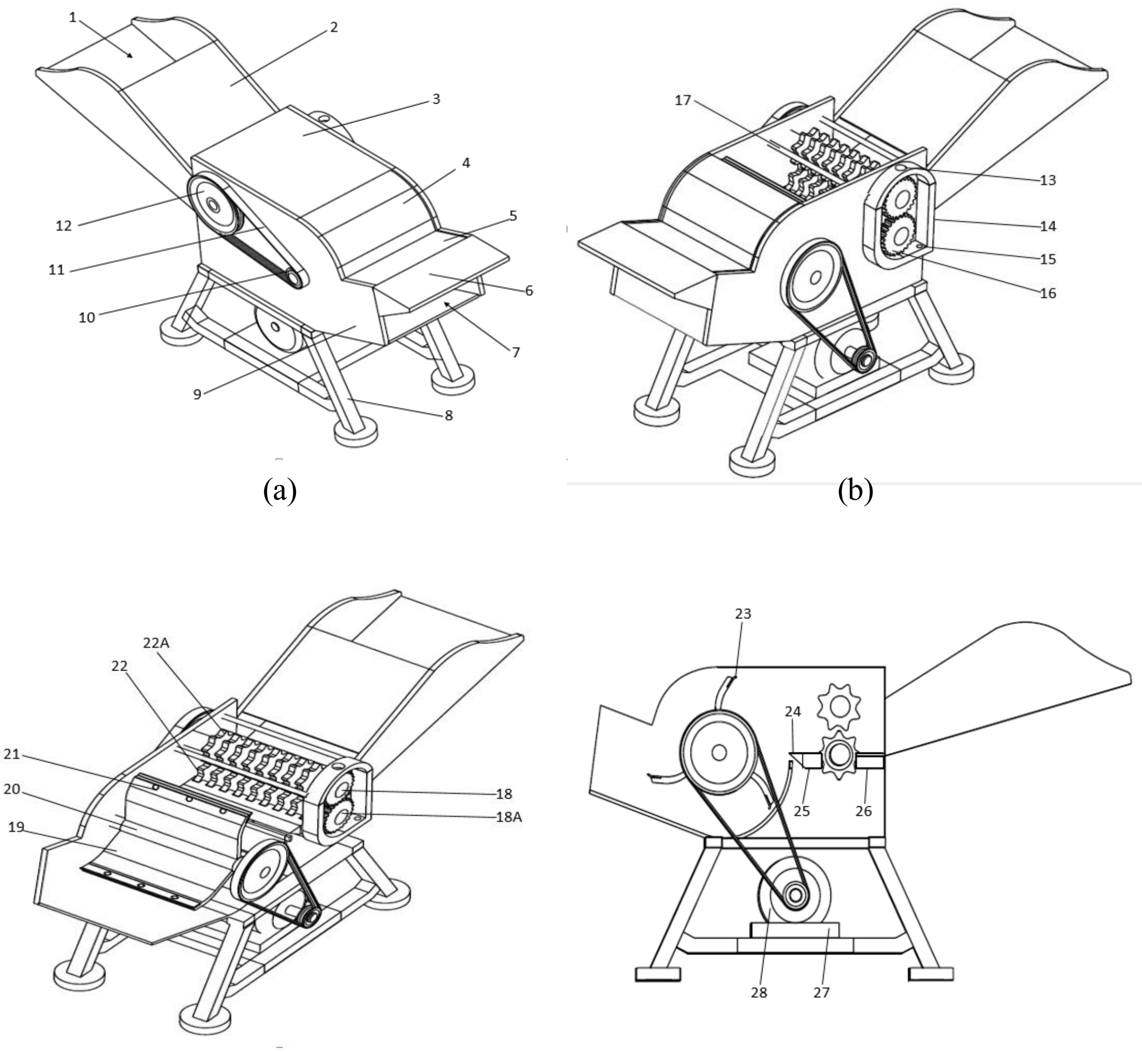



Fig. 3.1 (a), (b), (c) Schematic of chaff cutter machine, and (d) Side view of chaff cutter machine

Table 3.1 chaff cutter components names

| | |
|---|---|
| 1. Feed before cutting | 16. Spur gear |
| 2. Feeding channel | 17. Supporting bar |
| 3. Adjustable plate | 18. Upper feed roller shaft |
| 4. Cutting box | 18A. Lower feed roller shaft |
| 5. Exhaust channel | 19. Cutting Blade holder |
| 6. Guide way | 20. Cutting blade holder shaft |
| 7. Feed after cutting | 21. Fastener |
| 8. Frame | 22. Lower feed roller shaft |
| 9. Casing | 22A. Upper feed roller shaft |
| 10. Driver pulley | 23. Cutting Blade |
| 11. V-Belt | 24. Shear Blade |
| 12. Driven pulley | 25. Shear Plate |
| 13. Oil inlet | 26. Base Plate |
| 14. Oil sump | 27. Motor Stand |
| 15. Oil exhaust | 28. Electric Motor |

## 3.3 Parts Description:

Now I will discuss the application of every part along with dimensions.

### 3.3.1 Feeding channel:

Firstly, the fodder is inserted into the feeding channel and then it allows the forage to move forward towards the feeding rollers. It helps to remove injuries while inserted the fodder into it.It is inclined at 15 degree so that forage will not accumulate in it.[12]

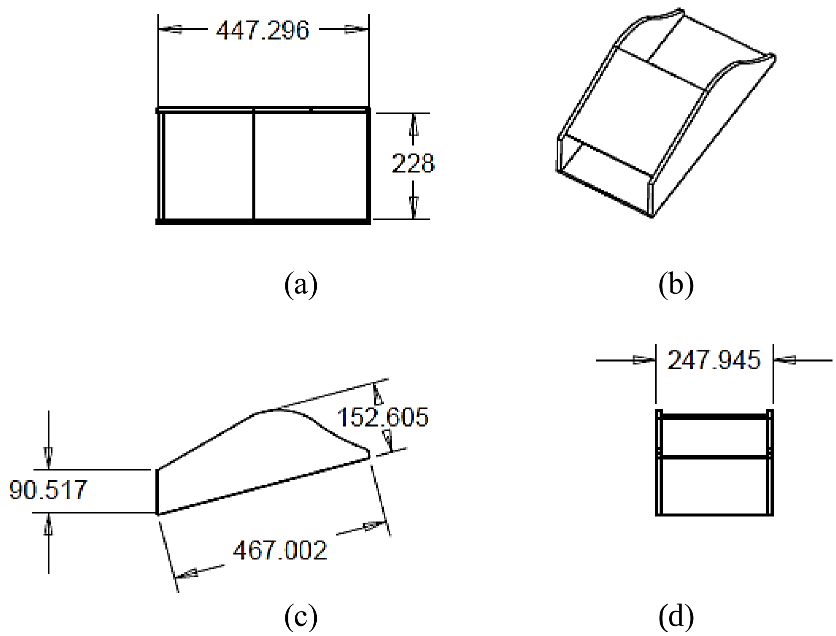



Fig. 3.2 Feeding channel (a) Top view, (b) Isometric view, (c) Front view and (d) Side view

### 3.3.2 Oil sump:

In order to reduce friction between gears, proper lubrication is provided with the help of oil sump. There is inlet and outlet in oil sump in order to remove used oil and enter the fresh oil.

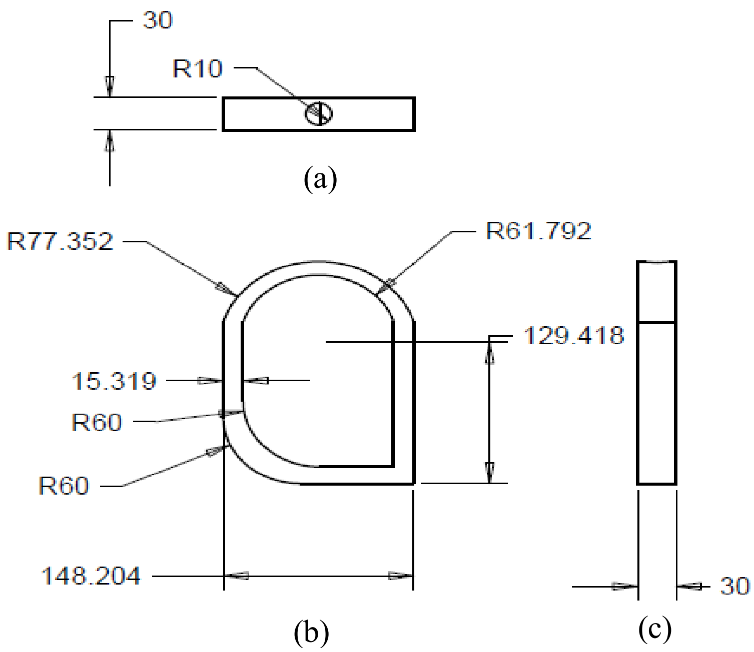



Fig. 3.3 Oil Sump(a) Top view, (b) Front view and (c) Side view

### 3.3.3 Feeding rollers:

There are two feed rollers one is upper feed roller and the other is lower feed roller.Upper feed rollers are eight in numbers and lower feed rollers are nine in numbers.They move opposite to each other. This rotation helps the fodder to move forward to the shear blade.[24]

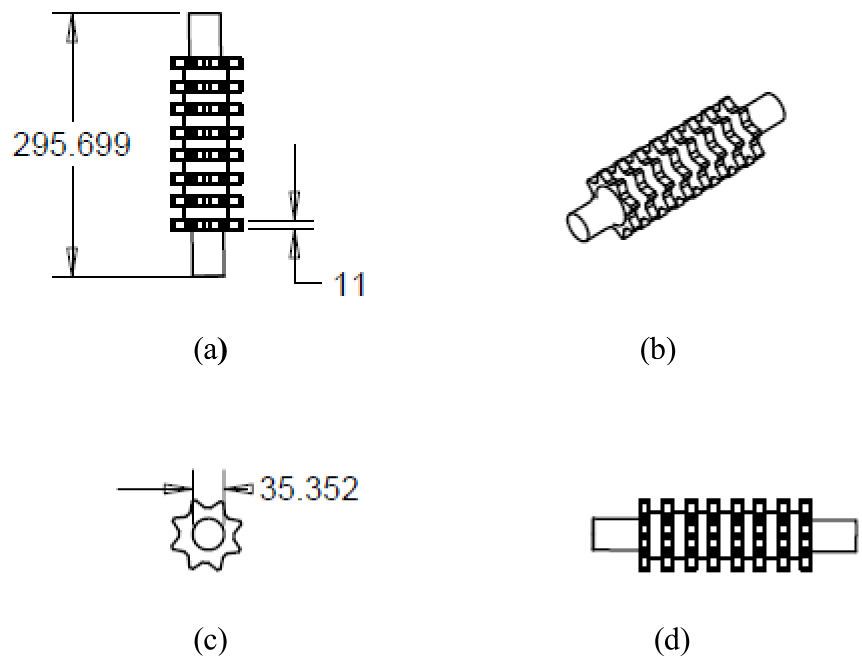



Fig. 3.4 Feeding Roller (a) Top view, (b) Isometric view, (c) Front view and (d) Side view

### 3.3.4 Adjustable plate:

Feeding rollers are covered by adjustable plate. Its dimensions in mm are given as follow:

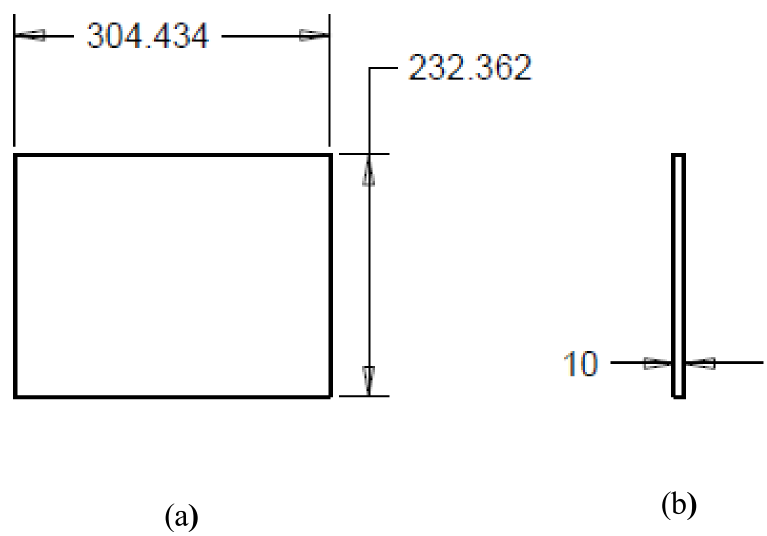
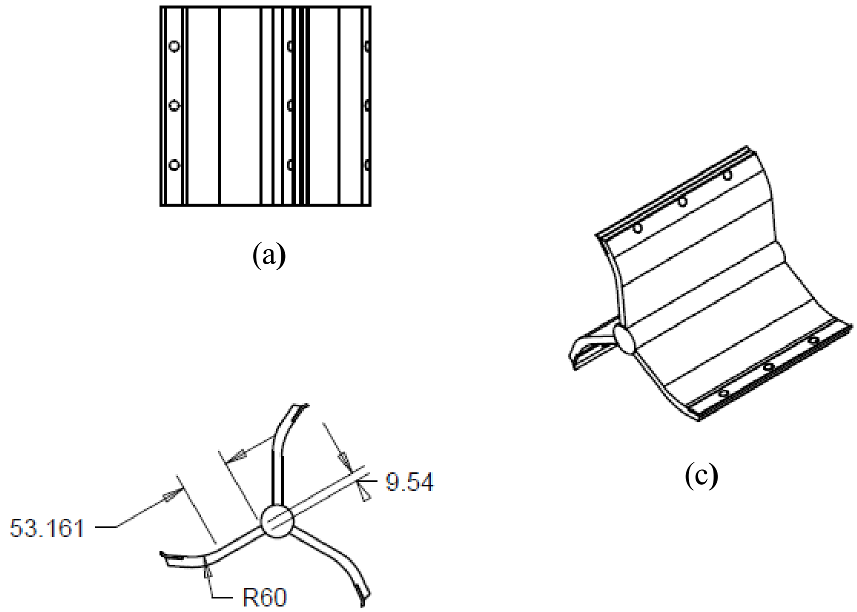



Fig. 3.5 Adjustable Plate(a) Top view and (b) Side view

### 3.3.5 Cutting blade holder:

Cutting blade is mounted on it with the help of fasteners. It is of inclined shape.




(b)

Fig. 3.6 Cutting Blade Holder (a) Top view, (b) Front view and (c) Isometric view

### 3.3.6 Cutting blade:

There are three cutting blades used in chaff cutter machine. Their material is high carbon steel. Because of it, they have long durability.

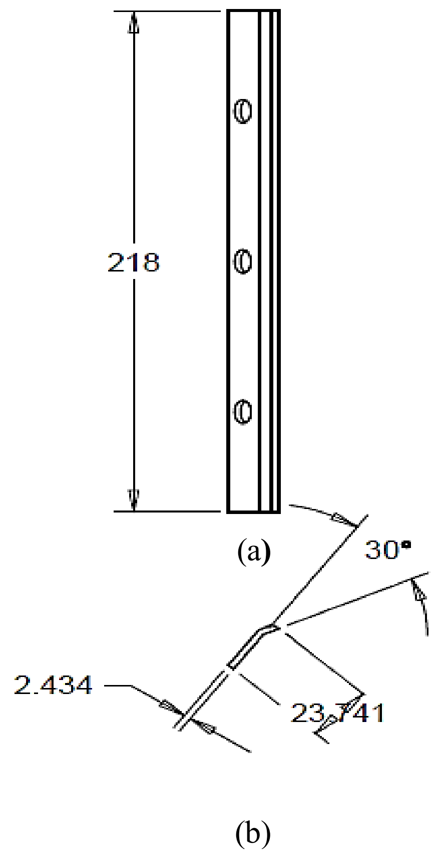



Fig. 3.7 Cutting Blade(a) Top view and (b) Front view

### 3.3.7 Cutting box:

Cutting blade holder and cutting blades are covered by cutting box. Cutting takes place inside it.

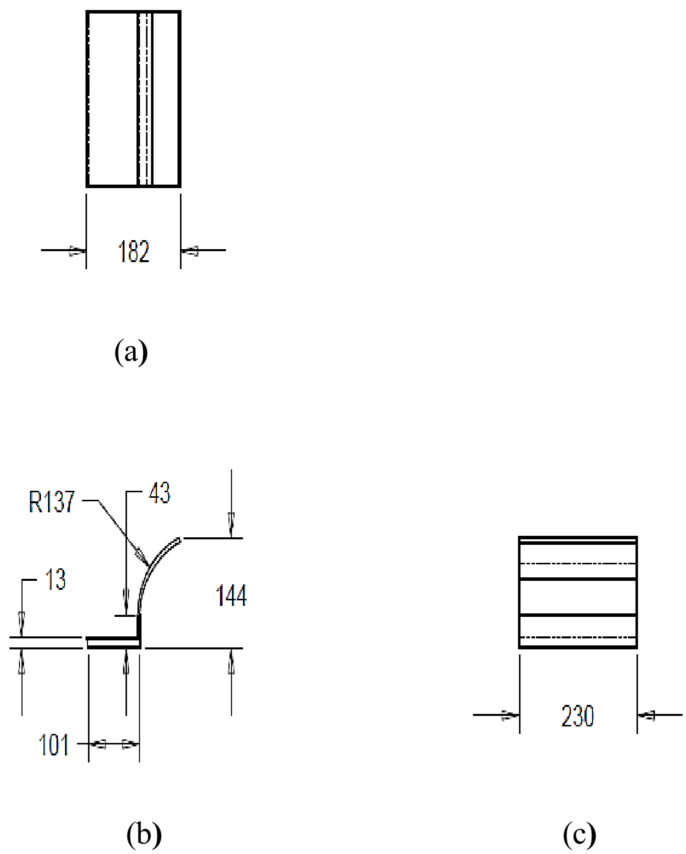
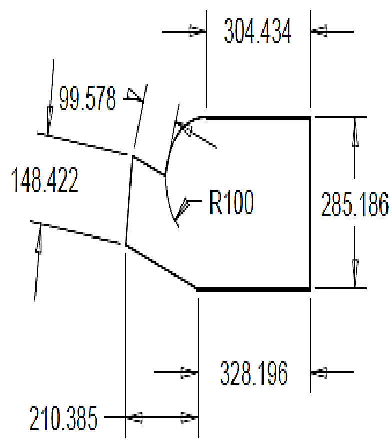



Fig. 3.8 Cutting Box (a) Top view, (b) Front view and (c) Side view

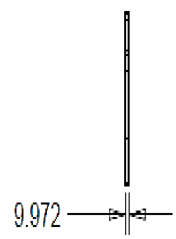
### 3.3.8 Casing:

All the mechanism excluding feeding channel is covered by casing sideways.

(a)




(b)




(c)

Fig. 3.9 Casing (a) Top view, (b) Front view and (c) Side view

### 3.3.9 Guideway:

It is the last part of chaff cutter machine. It helps the cutting forage to move straight.

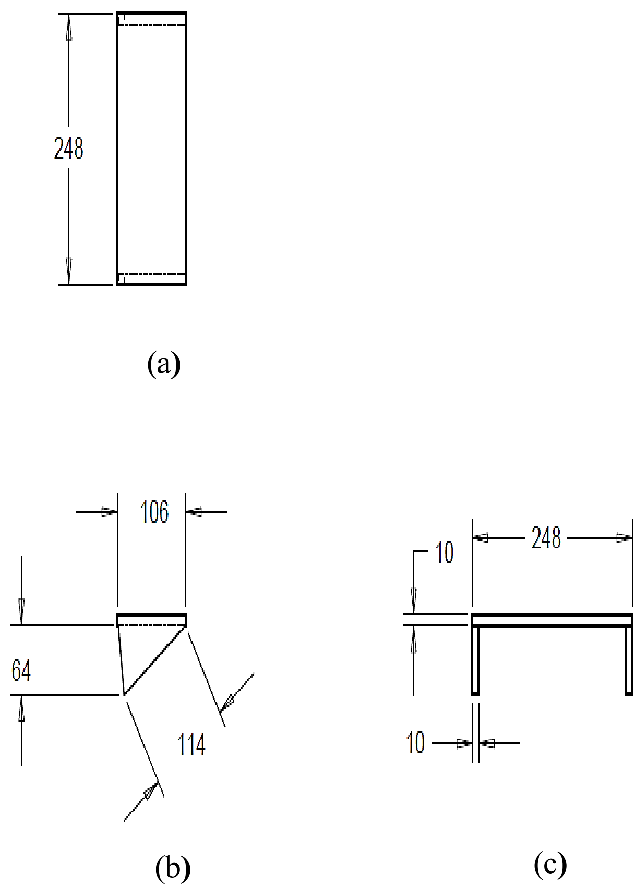



Fig. 3.10 Guide way (a) Top view, (b) Front view and (c) Side view

### 3.3.10 Frame:

All the weight of machine lies on frame. Because of frame, this machine is portable.

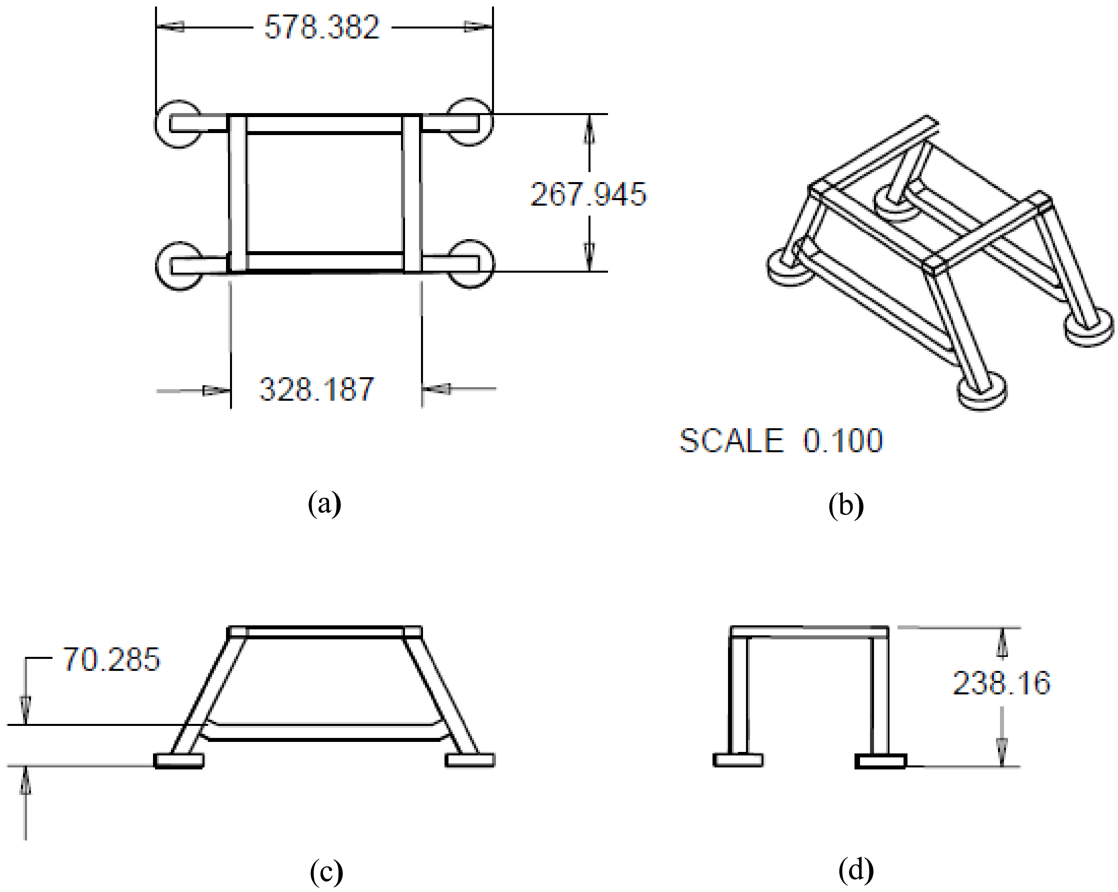



Fig. 3.11 Frame(a) Top view, (b) Isometric view, (c) Front view and (d) Side view

## 3.4 Methodology:

The complete structure of portable and safe chaff cutter machine was modelled based on the analysis of forage processing and existing problems in production scenario. The fodder cutter machine contained three modules; feeding module, cutting and throwing module and power transmission module. The feeding module comprised of feeding channel, one base plate, one shear plate and two feed rollers. The function of feeding channel was to deliver the chaff toward the pair of feed rollers. The lower feed roller inserted between the base plate and shear plate. Both feed rollers had opposite rotations to move the chaff forward. Cutting and throwing module consisted of shear blade, cutting blade, cutting box and discharge channel. Chaff, after passed through into feed rollers come in contact with shear blade and cutting blade. Shear blade fastened with shear plate while cutting blades mounted on the cutting blade holders. The cutting blades acted tangentially to the shear blade and the small pieces of feed thrown tangentially along the discharge channel. In power transmission module electric motor used to transmit mechanical power to cutting blade shaft. Cutting blade shaft transmitted power via belt and pulley to the upper feed rollers shaft. Upper feed roller shaft used to transmit power to lower feed roller shaft through spur gear. The frame supported the whole machine elements. Fig. 1 illustrated the schematics of the Portable and Safe Chaff Cutter Machine. The utility model has the advantage of good automatic feed effect, reduced the number of workers, reduced labor intensity, improved the efficiency, avoided personal injuries, and short crops and long crops could be all fed simultaneously.[10]


Fig. 3.12 Mechanism of Chaff Cutter Machine

Chapter 4

# DESIGN CALCULATIONS OF BASIC FUNCTIONAL UNITS

## 4.1 Choice of motor:

With the help of survey, it is analyzed that the torque required for chaff cutter machines is 30-70 Nm. So we take the net amount which is 50 Nm and number of revolutions required are N = 240 rpm.[25]

P = 2*3.14*240*50/60 = 1.2 kW

Hence 2hp motor will be used.

P = 2*0.746 W = 1.5 kW

## 4.2 Design of belt and pulley:

### 4.2.1 Input parameters:

T=50Nm

$N_1$ (Motor speed) = 540rpm

$N_2$ (blade shaft) = 240 rpm

P= n1.5 Kw (2hp)

### 4.2.2 Choice of belt section:-

Based on speed of faster shaft (rpm) and design power (KW) , we select section “A” type of belt from graph.

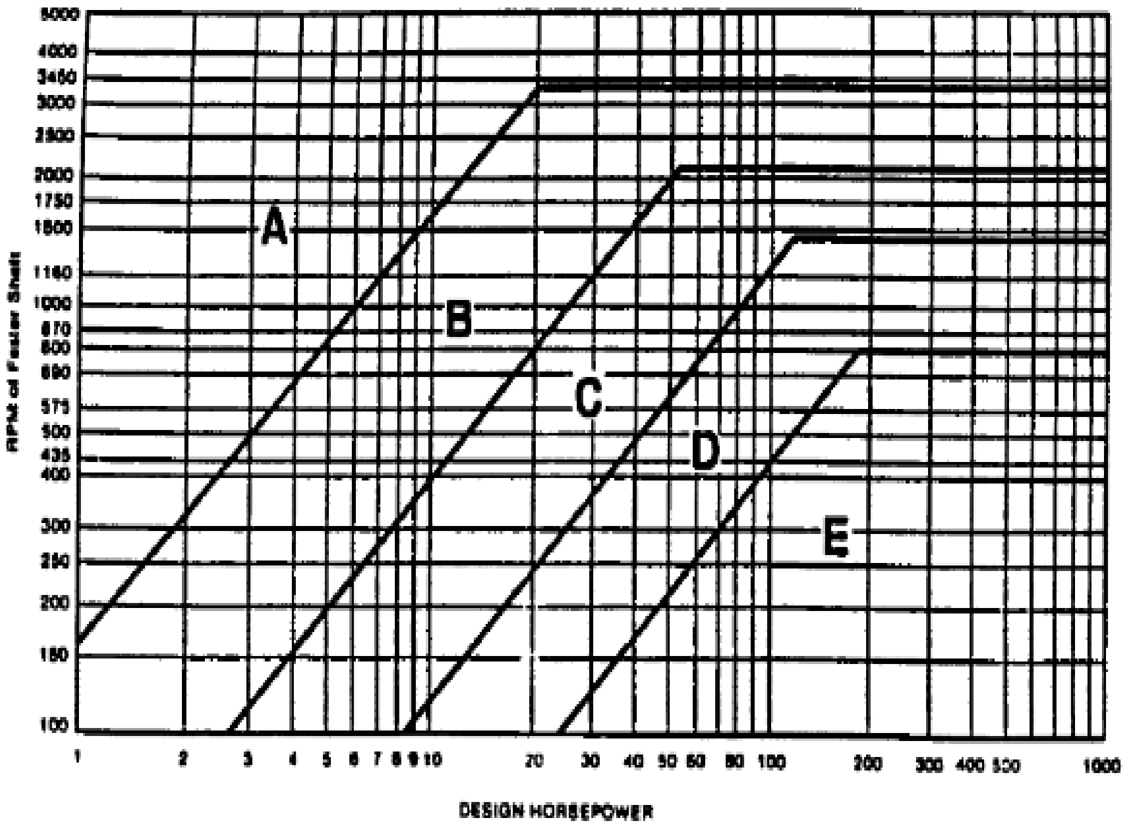



Fig. 4.1 Cross sections of V belt

From table

Table 4.1 Standard V belt data

**V BELTS**

| Data on Standard V- belt sections: | | | | | |
|---|---|---|---|---|---|
| Cross-section Symbol | Usual load of drive | Recommended min. pulley pitch diameter | Nominal top width | Nominal thickness | Weight per m |
| | kW | d,mm | W,mm | T,mm | kgf |
| A | 0.75 - 5 | 75 | 13 | 8 | 0.106 |
| B | 2 - 15 | 125 | 17 | 11 | 0.189 |
| C | 7.5 - 75 | 200 | 22 | 14 | 0.343 |
| D | 22 - 150 | 355 | 32 | 19 | 0.596 |
| E | 30 - 190 | 500 | 38 | 23 | ----- |

Recommended minimum pulley diameter

$d_{min}$=75 mm

### 4.2.3 Choice of diameters [26]

Equivalent pitch diameters $(d_e) = d_p * F_b$

$d_p$= pitch dia of smaller pulley

$F_b$ = pitch dia factor to account for variation of arc of contact

$d_{e\,max} = d_{p\,max} * F_{b\,max}$

from table

Table 4.2 Standard V belt data

| V BELTS | |
|---|---|
| Data on Standard V- belt sections: | |
| Maximum value of $d_e$ in the formula, mm | Belt cross-section symbol |
| 125 | A |
| 175 | B |
| 300 | C |
| 425 | D |
| 700 | E |

$d_{e\,Max}$= 125 mm

now speed ratio = i = $\frac{\text{Input RPM}}{\text{output RPM}}=\frac{540}{240}$=2.25

$F_{b\,max}$= 1.13 (from table)

Table 4.3 Pitch diameter factor of V belt

| Speed ratio range, D/d | Small dia. Factor, $F_b$ |
|---|---|
| 1 to 1.019 | 1.00 |
| 1.02 to 1.032 | 1.01 |
| 1.033 to 1.055 | 1.02 |
| 1.056 to 1.081 | 1.03 |
| 1.082 to 1.109 | 1.04 |
| 1.11 to 1.142 | 1.05 |
| 1.143 to 1.178 | 1.06 |
| 1.179 to 1.222 | 1.07 |
| 1.223 to 1.274 | 1.08 |
| 1.275 to 1.340 | 1.09 |
| 1.341 to 1.429 | 1.10 |
| 1.43 to 1.562 | 1.11 |
| 1.563 to 1.814 | 1.12 |
| 1.815 to 2.948 | 1.13 |
| 2.949 and over | 1.14 |

Now

$d_{p\,max}=\frac{\text{de max}}{\text{Fb max}}=\frac{125}{1.13}$= 110.619 mm

Therefore, diameter of smaller pulley should be between 75 to 110.6 mm

Standard Dias's (from table )

Table 4.4 Standard diameters of Pulley

| Recommended series of pulley diameters and tolerances, mm | |
|---|---|
| Nominal diameter | Tolerance on Nominal diameter |
| 40 | ± 0.5 |
| 45 | ± 0.6 |
| 50 | |
| 56 | ± 0.8 |
| 63 | |
| 71 | ±1.0 |
| 80 | |
| 90 | ±1.2 |
| 100 | |
| 112 | |
| 125 | ±1.6 |
| 140 | |
| 160 | ± 2.0 |
| 180 | |
| 200 | |
| 224 | ± 2.5 |
| 250 | |
| 280 | ± 3.2 |
| 315 | |
| 355 | |
| 400 | ± 4.0 |
| 450 | |
| 500 | |



Hence, we select the diameter of smaller pulley (driver) = 100mm

$i=\frac{D}{d}$

= 2.25 * 100= 225=D (driven dia)

## 4.2.4 Choice of center distance ( C )

Center distance = $C=D * \frac{C}{D}$

$C_{max} = 2*(D+d)$

$C_{min} = 0.55*(D+d) + T$

Where T = nominal thickness (from table)

Table 4.5 Standard dimensions of V Belt

**V BELTS**

| Data on Standard V- belt sections: | | | | | |
|---|---|---|---|---|---|
| Cross-section Symbol | Usual load of drive | Recommended min. pulley pitch diameter | Nominal top width | Nominal thickness | Weight per m |
| | kW | d,mm | W,mm | T,mm | kgf |
| A | 0.75 - 5 | 75 | 13 | 8 | 0.106 |
| B | 2 - 15 | 125 | 17 | 11 | 0.189 |
| C | 7.5 - 75 | 200 | 22 | 14 | 0.343 |
| D | 22 - 150 | 355 | 32 | 19 | 0.596 |
| E | 30 - 190 | 500 | 38 | 23 | ----- |

T = 8 mm

$C_{max}$ = 2* (225+100) = 650 mm

$C_{min}$ = 0.55* (225+100)+8 = 186.75 mm

So center distance must be between 186.75 to 650 mm

$C=D * \frac{C}{D}$

$\frac{C}{D}$ from table ( i=2.25 ≈ 2)

Table 4.6 C/D ratio of Pulley

| Selection of center distance, C | | | | | | |
|---|---|---|---|---|---|---|
| Speed ratio, i=D/d | 1 | 2 | 3 | 4 | 5 | 6 to 9 |
| Recommended C/D ratio | 1.5 | 1.2 | 1.0 | 0.95 | 0.9 | 0.85 |

So, $\frac{C}{D}$ = 1.2 (putting in above equation)

C=225 * 1.2

C=270 mm (10.62 in)

### 4.2.5 To find the nominal pitch length of belt (L)

$$L = 2*C + \frac{\pi}{2} * (D + d) + \frac{(D-d)^2}{4C}$$

C=270 mm

D=225mm

d=100mm

L=1064.97≈1051 Standard length (from table)

Table 4.7 Standard sizes of V-Belts

| Nominal inside length, pitch length, permissible length variations and correction factor for standard sizes of V- belts. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nominal Inside length limits in length within a matched set | Normal pitch length | | | | | Pitch length variation | | Correction factor, $F_c$ | | | | |
| | CROSS - SECTION | | | | | Pitch length | Max. variation in length within a matched set | Belt cross - section symbols | | | | |
| | A | B | C | D | E | | | | | | | |
| mm | mm | mm | mm | mm | mm | mm | mm | A | B | C | D | E |
| 610 | 645 | - | - | - | - | +11.4 -6.4 | 2.5 | 0.80 | - | - | - | - |
| 660 | 696 | - | - | - | - | | | 0.81 | - | - | - | - |
| 711 | 747 | - | - | - | - | | | 0.82 | - | - | - | - |
| 787 | 823 | - | - | - | - | +12.5 -7.5 | | 0.84 | - | - | - | - |
| 813 | 848 | - | - | - | - | | | 0.85 | - | - | - | - |
| 889 | 925 | 932 | - | - | - | | | 0.87 | 0.81 | - | - | - |
| 914 | 950 | - | - | - | - | | | 0.87 | - | - | - | - |
| 965 | 1001 | 1008 | - | - | - | +14.0 -8.9 | | 0.88 | 0.83 | - | - | - |
| 991 | 1026 | - | - | - | - | | | 0.88 | - | - | - | - |
| 1016 | 1051 | 1059 | - | - | - | | | 0.89 | 0.84 | - | - | - |
| 1067 | 1102 | 1110 | - | - | - | | | 0.90 | 0.85 | - | - | - |
| 1092 | 1128 | - | - | - | - | | | 0.90 | - | - | - | - |
| 1168 | 1204 | 1212 | - | - | - | | | 0.92 | 0.87 | - | - | - |
| 1219 | 1255 | 1262 | - | - | - | +16.0 -9.0 | 5.0 | 0.93 | 0.88 | - | - | - |
| 1295 | 1331 | 1339 | 1351 | - | - | | | 0.94 | 0.89 | 0.80 | - | - |
| 1372 | - | 1415 | - | | - | | | - | 0.90 | - | - | - |
| 1397 | 1433 | 1440 | - | - | - | | | 0.96 | 0.90 | - | - | - |
| 1422 | 1458 | 1466 | - | - | - | | | 0.96 | 0.90 | - | - | - |
| 1473 | 1509 | - | - | - | | | | 0.97 | - | - | - | - |
| 1524 | 1560 | 1567 | 1580 | - | - | | | 0.98 | 0.92 | 0.82 | - | - |



L=1051 mm

### 4.2.6 Calculation of design power capacity (Max)

For (A) type belt

P(kw)= [ .45$s^{-.09}$ - $\frac{19.62}{d_e}$- .765*10-4 $s^2$] S

S=$\frac{\pi d N_1}{60}$ (speed of belt)

V=s=2.827 m/s

de= dp * Fb

dp =100mm

Fb =1.13 from table w.r.t 'i'

de =100(1.13)

de = 113mm < de max (125mm)

now power =0.665 KW

### 4.2.7 To find the number of belts

$n_b \frac{P F_a}{KW * F_c * F_d}$

P= motor power

$F_a$=Service factor

Assuming medium duty service and upto10 hours service

$F_a$ = 1.1 (from table below)

Table 4.8 Service factor of V-Belt

**CORRECTION FACTORS FOR INDUSTRIAL SERVICE, $F_a$**

| Severity of service | Type of driven machines | Type of driving units | | | | | |
|---|---|---|---|---|---|---|---|
| | | AC Motors; Normal torque, squirrel cage, synchronous and split phase<br>DC motors; shunt wound, multiple cylinder internal combustion engines over 600 rpm | | | AC motors; high torque, high slip repulsion-induction, single phase, series wound and slipring<br>DC motors; series wound and compound wound. Single cylinder internal combustion engines. Multiple cylinder internal combustion engines under 600 rpm, line shafts, clutches, brakes, direct on-line starting | | |
| | | Upto 10 hr | Over 10 hr to 16 hr | Over 16 hr and continuous service | Upto 10 hr | Over 10 hr to 16 hr | Over 16 hr and continuous service |
| Light duty | Agitators for liquids, blowers and exhausters, centrifugal pumps and compressors, fans upto 7.5 kW (10 hp), and light duty conveyors. | 1.0 | 1.1 | 1.2 | 1.1 | 1.2 | 1.3 |
| Medium duty | Belt conveyors for sand, grain etc; dough mixers; fans over 7.5 kW (10 hp); generators; line shafts; laundry machinery; machine tools; punches, presses and shears; printing machinery; positive displacement rotary pumps; and revolving and vibrating screens. | 1.1 | 1.2 | 1.3 | 1.2 | 1.3 | 1.4 |
| Heavy duty | Brick machinery, bucket elevators, exciters, piston compressors, conveyors (drag-pan-screw), hammer mills, paper mill beaters, piston pumps, positive displacement blowers, pulverizers, saw mill and wood-working machinery and textile machinery. | 1.2 | 1.3 | 1.4 | 1.4 | 1.5 | 1.6 |
| Extra heavy duty | Crushers (gyratory-jaw-roll), mills (ball-rod-tube), hoists and rubber (calendars-extruders-mills) | 1.3 | 1.4 | 1.5 | 1.5 | 1.6 | 1.8 |



$F_c$ =Length correction factor

$F_c$ = 0.89 (w.r.t Normal pitch length selected) (from table below)

Table 4.9 Standard sizes of V-Belts

| Nominal inside length, pitch length, permissible length variations and correction factor for standard sizes of V- belts. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nominal Inside length limits in length within a matched set | Normal pitch length | | | | | Pitch length variation | | Correction factor, $F_c$ | | | | |
| | CROSS - SECTION | | | | | Pitch length | Max. variation in length within a matched set | Belt cross - section symbols | | | | |
| | A | B | C | D | E | | | | | | | |
| mm | mm | mm | mm | mm | mm | mm | mm | A | B | C | D | E |
| 610 | 645 | - | - | - | - | +11.4 -6.4 | 2.5 | 0.80 | - | - | - | - |
| 660 | 696 | - | - | - | - | | | 0.81 | - | - | - | - |
| 711 | 747 | - | - | - | - | | | 0.82 | - | - | - | - |
| 787 | 823 | - | - | - | - | +12.5 -7.5 | | 0.84 | - | - | - | - |
| 813 | 848 | - | - | - | - | | | 0.85 | - | - | - | - |
| 889 | 925 | 932 | - | - | - | | | 0.87 | 0.81 | - | - | - |
| 914 | 950 | - | - | - | - | | | 0.87 | - | - | - | - |
| 965 | 1001 | 1008 | - | - | - | +14.0 -8.9 | | 0.88 | 0.83 | - | - | - |
| 991 | 1026 | - | - | - | - | | | 0.88 | - | - | - | - |
| 1016 | 1051 | 1059 | - | - | - | | | 0.89 | 0.84 | - | - | - |
| 1067 | 1102 | 1110 | - | - | - | | | 0.90 | 0.85 | - | - | - |
| 1092 | 1128 | - | - | - | - | | | 0.90 | - | - | - | - |
| 1168 | 1204 | 1212 | - | - | - | | | 0.92 | 0.87 | - | - | - |
| 1219 | 1255 | 1262 | - | - | - | +16.0 -9.0 | 5.0 | 0.93 | 0.88 | - | - | - |
| 1295 | 1331 | 1339 | 1351 | - | - | | | 0.94 | 0.89 | 0.80 | - | - |
| 1372 | - | 1415 | - | | - | | | - | 0.90 | - | - | - |
| 1397 | 1433 | 1440 | - | - | - | | | 0.96 | 0.90 | - | - | - |
| 1422 | 1458 | 1466 | - | - | - | | | 0.96 | 0.90 | - | - | - |
| 1473 | 1509 | - | - | - | | | | 0.97 | - | - | - | - |
| 1524 | 1560 | 1567 | 1580 | - | - | | | 0.98 | 0.92 | 0.82 | - | - |



$F_d$ = Correction factor for arc of contact

Firstly, find $\theta(\alpha)$ arc of contact and consult table to find $F_d$.

So,

$$\theta=\alpha=180^\circ - \left(\frac{D-d}{C}\right)*60^\circ$$

$$\theta=\alpha=180^\circ - \left(\frac{225-100}{270}\right)*60^\circ$$

$$\theta=\alpha=152.2^\circ$$

$F_d$=0.81 ( from table below)

Table 4.10 Correction Factor of V-Belts

| Correction Factor for Arc Of Contact, Fd | | |
|---|---|---|
| Arc of contact on smaller pulley (in degrees) | Correction factor (Proportion of 180° rating) | |
| | V-V | V-Flat |
| 180 | 1 | 0.75 |
| 177 | 0.99 | 0.76 |
| 174 | 0.99 | 0.76 |
| 171 | 0.98 | 0.77 |
| 169 | 0.97 | 0.78 |
| 166 | 0.97 | 0.79 |
| 163 | 0.96 | 0.79 |
| 160 | 0.95 | 0.8 |
| 157 | 0.94 | 0.81 |
| 154 | 0.93 | 0.81 |
| 151 | 0.93 | 0.82 |
| 148 | 0.92 | 0.83 |
| 145 | 0.91 | 0.83 |
| 142 | 0.9 | 0.84 |
| 139 | 0.89 | 0.85 |
| 136 | 0.88 | 0.85 |
| 133 | 0.87 | 0.86 |
| 130 | 0.86 | 0.86 |
| 127 | 0.85 | 0.85 |
| 123 | 0.83 | 0.83 |
| 120 | 0.82 | 0.82 |
| 117 | 0.81 | 0.81 |

$\alpha$=2.65rad

$n_b = \frac{1.5*1.1}{0.6659*0.89*0.81}$

$n_b$ =3.43 ≈3

$F_a = F_c = F_d$ = Modification factors

## 4.2.8 To find the actual center distance

$C=A+\sqrt{A^2-B}$

$A=\frac{L}{4}-\pi\ \frac{225+100}{8}$

= 1953.125

C= 262.81mm

## 4.2.9 Design calculation of belt tension ($T_1$ & $T_c$)

$T_c = mv^2$

V = 2.827 m/s

m= mass per meter length = 0.106 (from table below)

Table 4.11 Standard sizes of V-Belts

**V BELTS**

| Data on Standard V- belt sections: | | | | | |
|---|---|---|---|---|---|
| Cross-section Symbol | Usual load of drive | Recommended min. pulley pitch diameter | Nominal top width | Nominal thickness | Weight per m |
| | kW | d,mm | W,mm | T,mm | kgf |
| A | 0.75 - 5 | 75 | 13 | 8 | 0.106 |
| B | 2 - 15 | 125 | 17 | 11 | 0.189 |
| C | 7.5 - 75 | 200 | 22 | 14 | 0.343 |
| D | 22 - 150 | 355 | 32 | 19 | 0.596 |
| E | 30 - 190 | 500 | 38 | 23 | ----- |

$T_c = 0.106 * 2.827^2 = 0.8471$

β (Groove angle )

2β= 34° (from table below)

Table 4.12 Standard sizes of Pulleys

**DIMENSIONS OF STANDARD V-GROOVED PULLEYS**

| Groove Cross Section | Pitch width $l_p$ mm | Minimum distance down to pitch line b mm | Pulley pitch diameter $d_p$ | Angle A Tolerance ±1/2° | Minimum depth below pitch line h mm | Centre to centre distance of grooves e mm | Tolerance on e* mm |
|---|---|---|---|---|---|---|---|
| A | 11 | 3.3 | Under 75 mm to 67 mm | 32° | 8.7 | 15 | ± 0.3 |
| | | | **Recommended min. 75 mm and under 125 mm | 34° | | | |
| | | | 125 mm and over | 38° | | | |
| B | 14 | 4.2 | Under 125 mm to 117 mm | 32° | 10.8 | 19 | ± 0.4 |
| | | | **Recommended min. 125 mm and under 200 mm | 34° | | | |
| | | | 200 mm and over | 38° | | | |
| C | 19 | 5.7 | Under 200 mm to 175 mm | 34° | 14.3 | 25.5 | ± 0.5 |
| | | | **Recommended min. 200 mm and under 300 mm | 36° | | | |
| | | | 300 mm and over | 38° | | | |
| D | 27 | 8.1 | Under 355 mm to 300 mm | 34° | 19.9 | 37 | ± 0.6 |
| | | | **Recommended min. 355 mm and under 500 mm | 36° | | | |
| | | | 500 mm and over | 38° | | | |
| E | 32 | 9.6 | | | 23.4 | 44.5 | ± 0.7 |



β= 17°

μ = Coefficient of friction =0.25

Power transmitted per belt = $(T_1 - T_2)$ V

$$\frac{1.5 * 10^3}{3} = (T_1 - T_2)\ 2.827$$

$$T_1 - T_2 = 176.86 \qquad (1)$$

$$\frac{T_1 - T_c}{T_2 - T_c} = e^{\mu\theta/\sin\beta}$$

$$\frac{T_1 - 0.8471}{T_2 - 0.8471} = 9.689$$

$$T_1 - 0.8471 = (T_2 - 0.8471)9.689$$

$$T_1 - 0.8471 = 9.689T_2 - 8.2075$$

$$T_1 - 9.689T_2 = -7.360 \qquad (2)$$

Solving Eq (1) & Eq (2)

$$9.689T_1 - 9.689T_2 = 176.86$$

$$T_1 - 9.689T_2 = 7.360$$

$8.689T_1$ = 1720.95

$T_1$ = 198.06 N

Putting in Eq (1) to find $T_2$

$$198.06 - T_2 = 176.86$$

$$T_2 = 21.2\ N$$

### 4.2.9 To find the stress induced :

$$Stress\ induced\ = \frac{\max tension}{cross\ sectional\ area}$$

Cross sectional area = $\frac{1}{2}$ (W+b)T for section A

For A type belt

W=13

T=8

B=8.12

(Tan17*8) =2.44=x

b=W-2(2.44) b=W-2x

Area =(1/2)(13+8.12)8

Area= 84.48 ≈ 85 $mm^2$

$$\text{Stress induced} = \frac{198.06}{85}$$

$$\text{Stress induced} = 2.33\ N/mm^2$$

### 4.2.10 To Find the max power transmitted:

$$P\ = (T_1 -\ T_2)V$$

$$P\ = (198.06 - 21.2)2.827$$

$$P\ = 499.9W \approx 500W$$

$$n = number\ of\ v\ belts = \frac{Total\ power\ transmitted}{power\ transmitted\ per\ belt}$$

### 4.2.11 To find the width of pulley:

$$width\ of\ pulley = (n - 1\ )e + 2f$$

f= Edge of pulley to first groove centre

n = Total number of belts

e = centre to centre distance of grooves

(from table above)

f= 10mm

e= 15mm

so, for n=3

$$width\ of\ pulley = (3 - 1)15| + 2 * 10$$

$$= 50mm$$

**For pulleys (3) & (4)**

d= 100mm

n= 240 RPM

D= 225mm

N= ?

$$N = 106.6\ RPM$$

$$N = 107\ RPM$$

## 4.3 Design of spur gear:

### 4.3.1 Input parameters:

P= 1.5 KW

N =107RPM

### 4.3.2 Common selections:

Table 4.13 Selection of parameters

| No. | Parameters | Options | selection |
|---|---|---|---|
| 1 | Tooth profile | Cylindrical/involute | Involute |
| 2 | Pressure angle | 14.5/20/25 | 20(most common) |
| 3 | Type of tooth | Full depth / stub tooth | Full design |
| 4 | Quality of cut | Commercial cut/precision cut | Precision cut |
| 5 | Type of system | Open / closed | Closed |
| 6 | Type of gearing | Corrected/non-corrected | Non-corrected |
| 7 | Gear box layout | Symmetrical/unsymmetrical | Unsymmetrical |

### 4.3.3 Calculate the number of teeth on pinion:

Formula to avoid the interference between gears to find the number of teeth on pinion is

$$z_1 = \frac{2f_o}{sin^2\alpha}$$

$F_o$= height factor

For all depth tooth

$F_o$=1 (from table below)

Table 4.14 Standard height factor Gears

| SPUR, HELICAL AND BEVEL GEARS | | |
|---|---|---|
| Symbol | Unit | Nomenclature |
| a | cm | Centre distance, to be rounded off to R 10 series in mm* |
| R | cm | Cone distance |
| i | – | Gear ratio, $(Z_2/Z_1) > 1$ Standard Gear Ratio, Table-4 |
| Z | – | Number of teeth, $Z_1$ on pinion & $Z_2$ on wheel |
| m | mm | Standard module, Table 1* |
| $m_n$ | mm | Standard normal module, Table 1* |
| b | cm | Face width |
| $\alpha$ | degrees | Pressure angle, standard $\alpha$ =20°. Other pressure angles in vogue 14° 30 & 15° |
| $\beta$ | degrees | Helix angle; 8° to 25° for Helical gears 25° to 40° for Herringbone gears, Spiral angle, 8° to 35° & Zero degree for zero bevel gears |
| $f_0$ | – | Height factor, $f_0$ = 1 for Standard gear tooth $f_0$ = 0.8 for Stub gear tooth |
| c | – | Radial clearance, c = 0.25 m for standard gears. Other clearances in vogue c = 0.157 m; c = 0.167 m; c = 0.2 m & c = 0.3 m |
| X | – | Correction factor or Addendum modification coefficient for $S_0$ & S corrected gears |
| $\psi$ | – | $\psi$ = b/a, Table -10. Recommended values, Table - 11 |
| $\psi_m$ | – | $\psi_m$ = b/m, Table -12 |
| $\psi_y$ | – | $\psi_y$ = R/b, Table -13 |
| y | -- | Form factor, Table -18 |
| $y_v$ | -- | Form factor based on equivalent number of teeth on the virtual cylinder, $Z_v$ |
| | -- | $Z_v = Z / \cos^3 \beta$ for Helical & Herringbone gears |
| | -- | $Z_v$ = Z / cos d for Straight bevel gears |
| | -- | $Z_v = Z / (\cos d . \cos^3 \beta_{av})$ for Spiral bevel gears |



$\alpha$=20°

$$z_1 = \frac{2}{sin^2 20}$$

$$= 17.09 \approx 18 \ (no. of\ teeth\ on\ pinion)$$

Gear ratio (reduction ratio)=i=1

## 4.3.4 Selection of material:

1. Pinion as $40N_2CrIM.28$ (from table below)

Table 4.15 Stresses for Gear Materials

**Design Stress for Gear Materials**

Table 7

| I.S. classification | | HeatTreatment | $\sigma_u$ kgf/mm$^2$ | $\sigma_{-1}$ (Min).kgf/mm$^2$ | Endurance limit Numberof cycles | SurfaceHardness HB | Design stress | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | [σb], kgf/cm$^2$ | | [$\sigma_c$]kgf/cm$^2$ |
| | | | | | | | Module, m, in mm | | |
| | | | | | | | m upto 6 | m = 7 to 10 | |
| Cast Iron | Grade 20 | - | ≥20 | 10 | $10^7$ | 179 - 223 | 500 | 460 | 5000 |
| | Grade 25 | - | ≥25 | 12 | $10^7$ | 197 - 241 | 600 | 550 | 6000 |
| | Grade 35 | - | ≥35 | 13 | $10^7$ | 207 - 241 | 600 | 550 | 6000 |
| | Grade 35 | Heat Treated | ≥35 | 16 | $10^7$ | 300 Min | 800 | 750 | 7500 |
| Steel | C 45 | - | ≥63 | 27 | $10^7$ | 175 - 215 | 1400 | 1350 | 5000 |
| | 15Ni 2 Cr1Mo15 | Carburized | ≥90 | 55 | 25x$10^7$ | Case (500) Core (250) | 3200 | 3000 | 9500 |
| | 40Ni 2 Cr1Mo28 | Casehardened | ≥155 | 60 | 25x$10^7$ | Case (600) Core (250) | 4000 | 3800 | 11000 |

Design bending stress [$\sigma_b$] = 400 N/mm$^2$

Design surface stress or contact stress [$\sigma_c$] = 1100 N/mm$^2$

### 4.3.5 Calculation of Lewis form factor

Y= π * y

Y= (Lewis constant)

For α =20º

$$y = 0.154 - \frac{0.912}{z_1}$$

$$Y_1 = \pi\left(0.154 - \frac{0.912}{z_1}\right)$$

### 4.3.6 Determination of module

$$m = 1.26 * \sqrt{\frac{[M_T]}{Y_1 * \sigma_{b1} * \Phi_m * z_1}}$$

$M_T$ =nominal twisting moment transmitted by the pinion

$[M_T] = M_T * K_d K$ Design factor

$K_d$ = dynamic load factor

$K_w$ == nominal power transmitted in KW

$K_d K = 1.5$ (from table below)

**Table 4.16 Design torque for Gears**

**Design Twisting Moment, $[M_t]$**

| | |
|---|---|
| $[M_t] = M_t k_d k$ ... (4.0) Initially assume for symmetric scheme $k_d k = 1.3$ ... (4.1) | Mt, nominal twisting moment transmitted by the pinion, kgf.cm<br>hp, nominal horsepower transmitted<br>n, speed of rotation of pinion, rpm<br>$k_d$, dynamic load factor, table 15<br>kW, nominal power transmitted in kW |
| For unsymmetric and over-hanging scheme kd k = 1.5 ...(4.2) | |
| | |

$M_T = \frac{60 * P}{2\pi N_1} = \frac{60*1500}{2\pi*107} = 133.86$ Nm

$M_T = 133868.64$ N.mm Actual torque but we have to put the design torque.

$[M_T] = M_T * K_d K$

$= 133868.64 * 1.5$

$= 200802.96$ N.mm

$\Phi_m = b/m$

$b \leq d_1$ (For light and medium duty)

$b \leq 1.5d_1$ (for heavy duty )

b= face width

$d_1$ = pinion diameter

$\Phi_m = 10m$

So,

$$m = 1.26 * 3\sqrt{\frac{200802.96}{0.325 * 400 * 10 * 18}}$$

$$m = 2.59 \quad (Actual\ value\ for\ design\ purpose\ increase\ it\ to\ 20\%)$$

= 2.59 * .20

= 0.515

m = 2.579+0.515 ≈3.09 ≈ 3(standard value) (from table below)

### 4.3.7 Design based on contact stresses

(Checking of contact stresses)

$\sigma_c = 0.74 \text{ x } \frac{i+1}{a} \text{ x } \sqrt{\frac{i+1}{i+b}.E.[M]}$

Table 4.17 Standard values of Modules for gears

Recommended Series of Modules* mm IS: 2535 - 1963

| Preferred(1) |
|---|
| 1 |
| 1.25 |
| 1.5 |
| 2 |
| 2.5 |
| 3 |
| 4 |
| 5 |
| 6 |
| 8 |
| 10 |
| 12 |
| 16 |
| 20 |

i = Gear ratio

a = Center distance formula

b = Face with = 10m → 10 (3) → 30mm

$a = \frac{m(Z1 + Z2)}{2}$ = 54mm

E = Young's modulus

E = 2015 x $10^5$ N/$mm^2$ (from table below)

Table 4.18 Modulus of Elasticity for gears

**Equivalent Young's Modulus, $E_{eq} = 2 E_1 E_2 / E_1 + E_2$**

| Pinion, 1 | | Wheel, 2 | | | |
|---|---|---|---|---|---|
| Material | Young's Modulus, $E_1$, kgf/$cm^2$ | Material | Tensile strength $\sigma_u$ ,kgf/$mm^2$ | Young's Modulus $E_2$,kgf/$cm^2$ | Equivalent Young's Modulus $E_{eq}$, kgf/$cm^2$ |
| Steel | 2.15x$10^6$ | Steel | | 2.15 x $10^6$ | 2.15 x $10^6$ |
| | | CI | ≤ 28 | 1.1 x $10^6$ | 1.46 x $10^6$ |
| | | | > 28 | 1.4 x $10^6$ | 1.7 x $10^6$ |
| | | Bronze | | 1.2 x $10^6$ | 1.55 x $10^6$ |
| | | Nylon | | 7 x $10^4$ | 1.36 x $10^6$ |

$[M_T]$ = 200802.96 N-mm
$\sigma_c$ = 0.74 x 0.03703 x 53648.63
$\sigma_c$ = 1470.36 N/$mm^2$ > $[\sigma_c]$ so that design is not safe, we have to increase the value of module to next standard value which is 4, and recalculate $\sigma_c$
so,
m = 4
a = 72mm
b = 40mm
and
$\sigma_c$ = 955.033 N/$mm^2$ < $\sigma_c$
Now, this design is safe

### 4.3.8 Design based on dynamic load

$F_s > F_d$

$F_s$ = strength of gear

$F_d$ = Dynamic load acting on the gear

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

$F_s = 400 \times 40 \times 0.325 \times 4$

$F_d$ = 20.8 KN

$F_d = F_T \times C_v$ $d_1 = mz = 18(4) = 72mm$

$= \frac{2[MT]}{d1} \times \frac{5.5 + \sqrt{Vm}}{5.5}$ $V_m = \frac{\pi d1N1}{60}$

$V_m$ = mean pitch velocity $V_m = \frac{\pi(0.072)(107)}{60} = 0.4033$ m/s

$C_v$ = Velocity factor for precision cut

$F_d = \frac{2[200802.96]}{72} \times \frac{5.5 + \sqrt{(0.4033)}}{5.5}$

$F_d$ = 11.55KN

$F_s > F_d$ so our design is safe

### 4.3.9 Checking of wear load

$F_w > F_d$ ( safe design condition)

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

$d_1$ = 72mm Q = ratio factor

$Q = \frac{2 \, x \, i}{i+1} = 1$ K = load stress factor (material combination factor)

b = 40mm

$K = \frac{\sigma c12 \, x \, sin \, \alpha \, x \, [\frac{1}{E1} + \frac{1}{E2}]}{1.4}$

$\sigma_{c1}$ = actual contact stress = 1470.36 N/mm$^2$

K = 4.913 N/mm$^2$

$F_w = 72 \times 1 \times 40 \times 4.913$

$F_w$ = 14.14 KN

$F_w > F_d$ (Design is safe in wear load)

### 4.3.10 Design based on induced bending stress:

$\sigma_b$ = i+1/a.m.b.Y * $[MT]$

a= 72mm

m= 4mm

b= 40mm

Y=0.325

$\sigma_b = 107.26\ N/mm^2 < [\sigma_b] = 400\ N/mm^2$

So design is safe for m= 4mm

### 4.3.11 Specifications of gear:

**m = 4mm and z = 18**

- Pitch dia = d = mz = 72mm
- Circular Pitch = 3.1416*d/z = 12.56 mm
- Diametral pitch = z/d = 250m
- Addendum = 1m= 4mm
- Dedendum = 1.25m = 5mm
- Tooth thickness = 3.1416* m/2
- Tooth depth = 2.25 m = 9mm
- Tip dia = d + 2m= 80mm
- Root dia = d-2.5m = 62mm
- Tip and root clearance = 0.25 m = 1mm
- Base dia = d cosa = 67.65 mm
- Face width = 10m = 40mm

## 4.4 Design of cutting blade holder shaft:

Material mild steel

### 4.4.1 Input parameters:

Allowable shear stress of material = 265N/mm$^2$

Allowable load = 300N (30kg)

Length of shaft = 300 mm

Max. bending moment (BM) = 300mm(300N) = 90000 N-mm

Torque:

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

$$T = \frac{1.5*1000*60}{2\pi*240} = 77.58 \text{ N-mm} = 59680 \text{ Nmm}$$

P = T x ω

$$\omega = \frac{P}{T} = \frac{1.5*1000}{59.68}$$

= 25.13 rad/sec

$$T_{eq} = \frac{\pi d^3 \tau}{16}$$

$$T_{eq} = \sqrt{T^2 + M^2}$$

$$T_{eq} = \sqrt{77.8^2 + 180000^2}$$

$T_{eq}$ = 107989.36 N-mm

$$90000 = \frac{\pi}{16} d^3 \tau$$

d = 15mm

## 4.5 Design of feed roller shaft:

### 4.5.1 Input parameters

Material mild steel

Allowable shear stress of material = 265N/mm$^2$

Allowable load = 300N (30kg)

Required Length of shaft = 275 mm

Max. bending moment (M) = 275mm(300N) = 82500 N-mm

Torque:

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

$$T = \frac{1.5*1000*60}{2\pi*107} = 133.86 \text{ N-m or } 133868.64\text{N-mm}$$

$$P = T \times \omega$$

$$\omega = \frac{2*\pi*N}{60} = \frac{2*\pi*107}{60}$$

$$= 11.20 \text{ rad/sec}$$

$$T_{eq} = \sqrt{T^2 + M^2}$$

$$T_{eq} = \sqrt{133868.64^2 + 2232^2}$$

$$T_{eq} = 157248.11\text{N-mm}$$

$$1800 = \frac{\pi}{16} d^3 \tau$$

$$d = 20\text{mm}$$

# Chapter 5

# RESULTS AND CONCLUSIONS

In this chapter, I will do simulation at different angles of cutting blades. After that, it will be analyzed that which angle of cutting blade is suited to the required length of cut.

## 5.1 Geometry:

Simulation is done in ANSYS software. I have selected the reference point which is the centre of cutting blade holder shaft. The coordinates of roller shaft 1 and 2 are as follow:

Feed roller 1 coordinates:

X = 221 mm

Y = -3 mm

Z = 0

Feed roller 2 coordinates:

X = 221 mm

Y = 85 mm

Z = 0

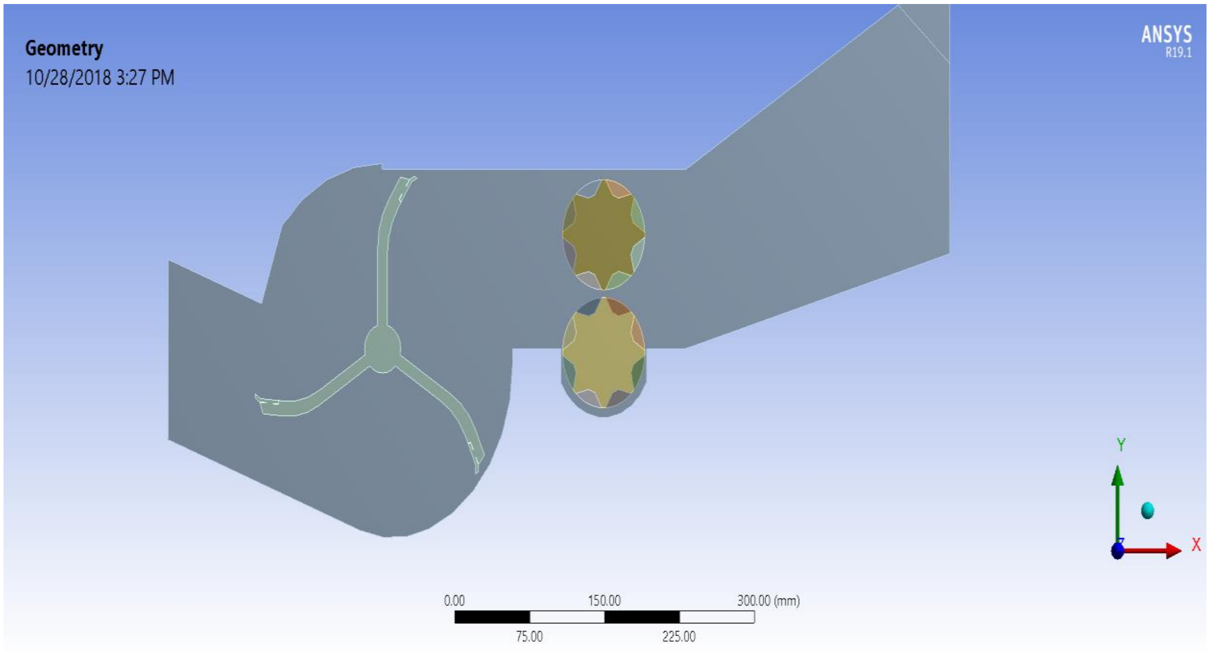



Fig. 5.1 Geometry of Chaff Cutter Machine

## 5.2 Meshing:

ANSYS Meshing is basically a common-purpose, intelligent, automatic high-presentation product. It creates the most suitable mesh for precise, effective multi-physics solutions. A mesh perfectively suited for a specific analysis can be created with a single click of mouse for all parts in a specimen. The figure below depicts the meshing analysis.

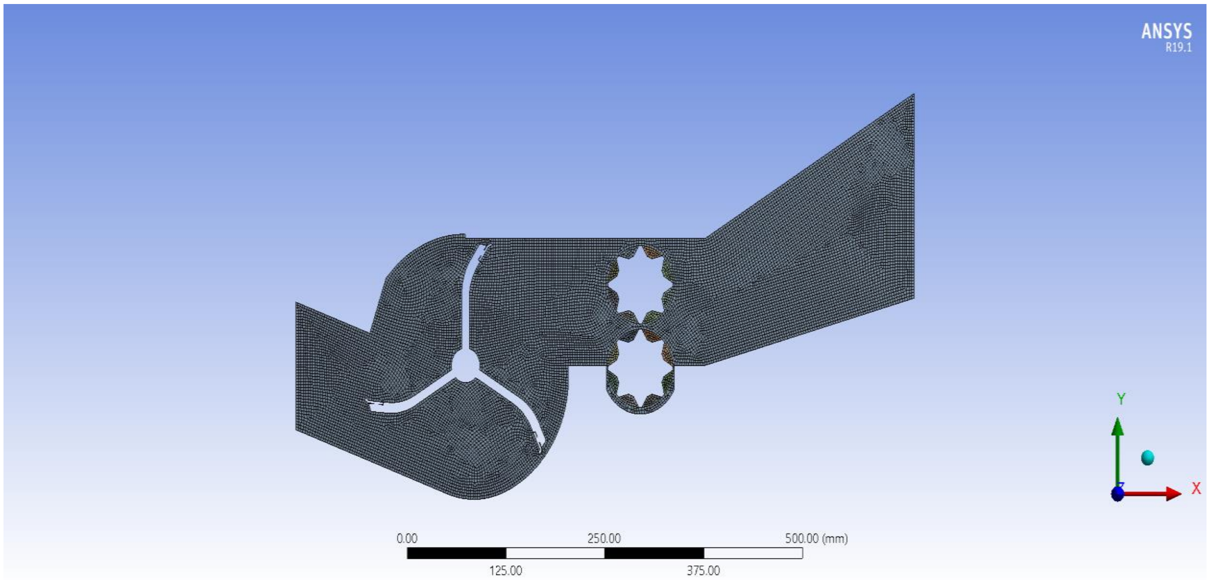



Fig. 5.2 Meshing

## 5.3 Simulation at an angle of 30 degree of cutting blade:

The figure given below denotes the behavior of cutting length with cutting blade angle of 30 degree.

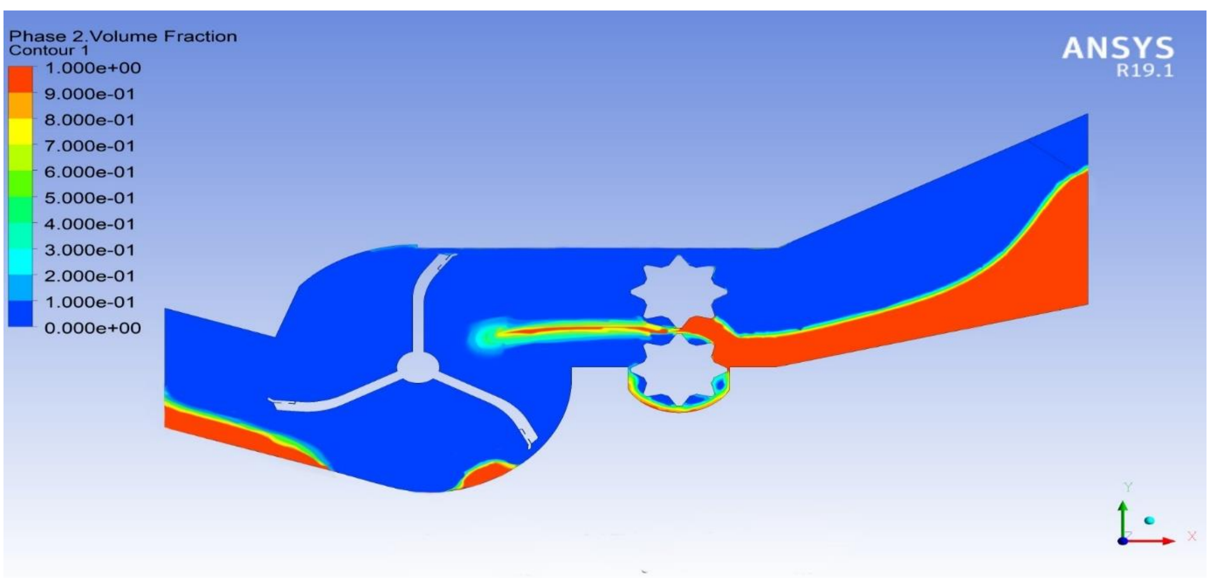



Fig. 5.3 Simulation at 30 degree of Cutting Blade

## 5.4 Simulation at an angle of 45 degree of cutting blade:

The figure given below denotes the behavior of cutting length with cutting blade angle of 45 degree. It can be seen that its behavior is different from 30 Degree.

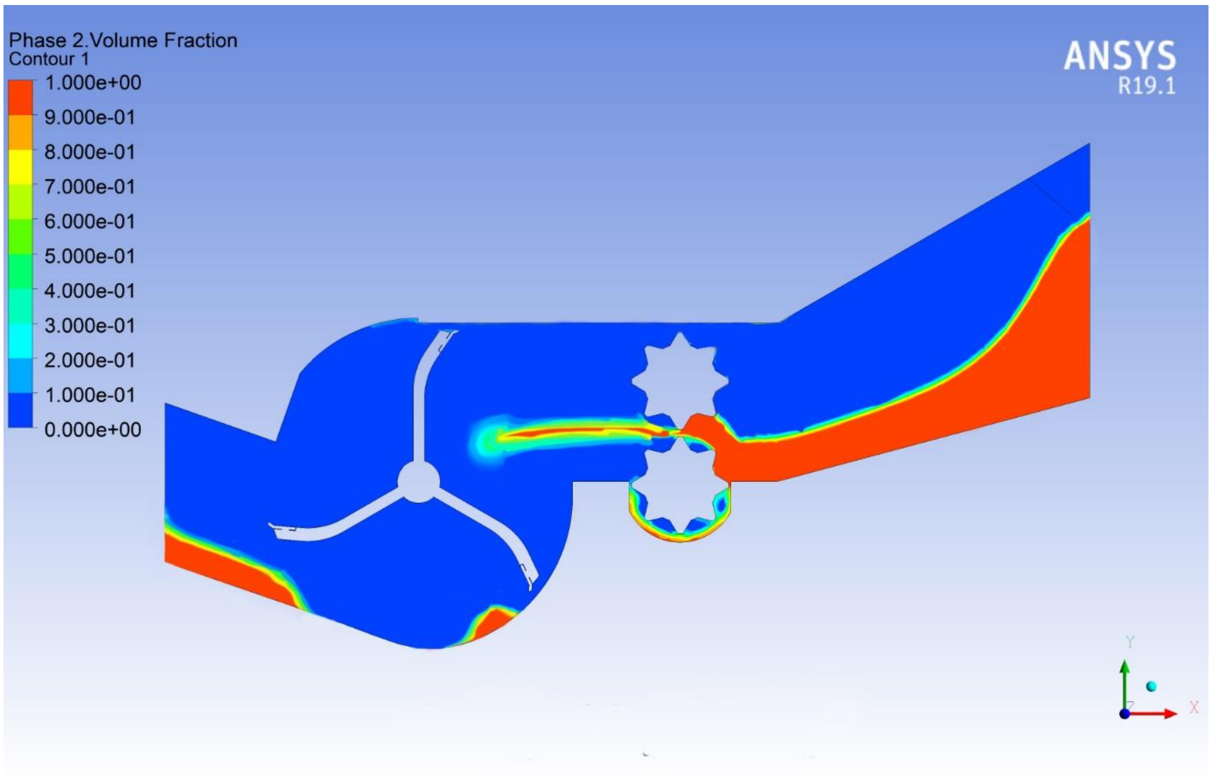



Fig. 5.4 Simulation at 30 degree of Cutting Blade

## 5.5 Simulation at an angle of 60 degree of cutting blade:

The figure given below denotes the behavior of cutting length with cutting blade angle of 60 degree. It can be seen that its behavior is different from 30 and 45 Degrees.

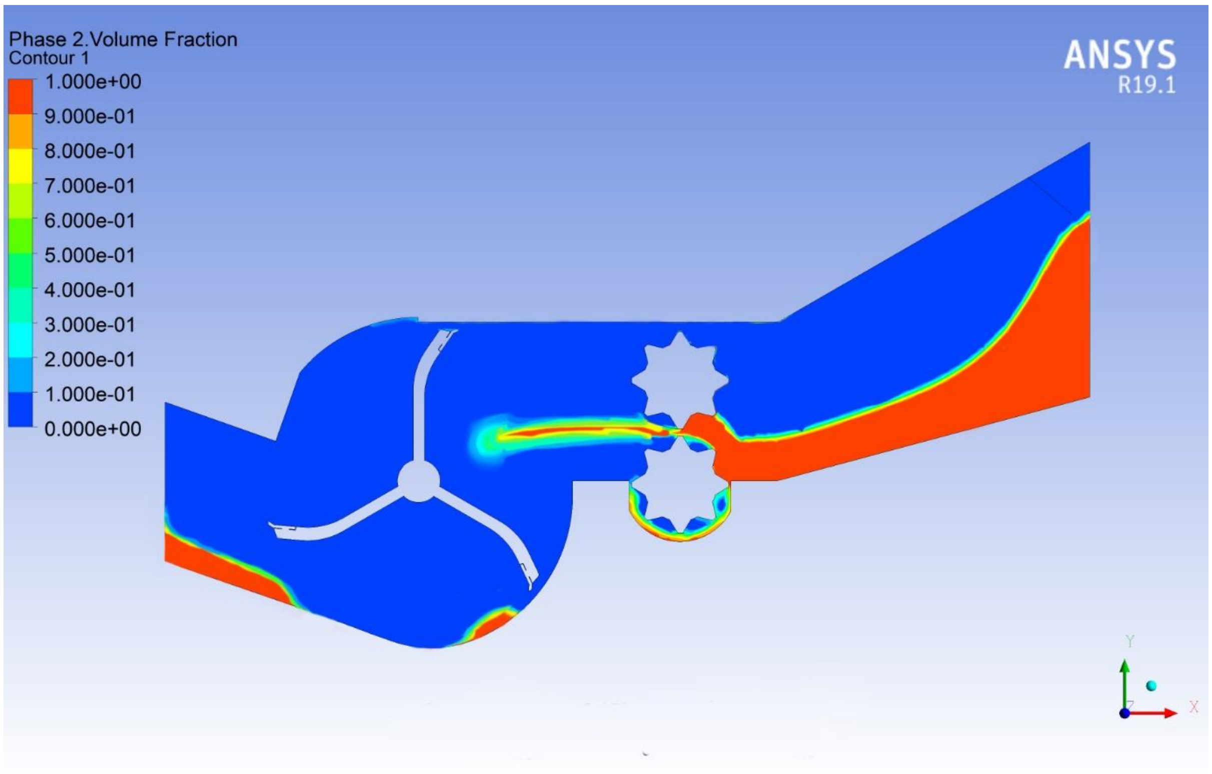



Fig. 5.5 Simulation at 60 degree of Cutting Blade

## 5.6 Length of cut versus angle of cutting blade:

The figure given below compares the length of cut with different angles of cutting blades. It can be clearly analyzed that angle 30 degree produces the higher length of cut as compare to angles 45 and 60 degrees.

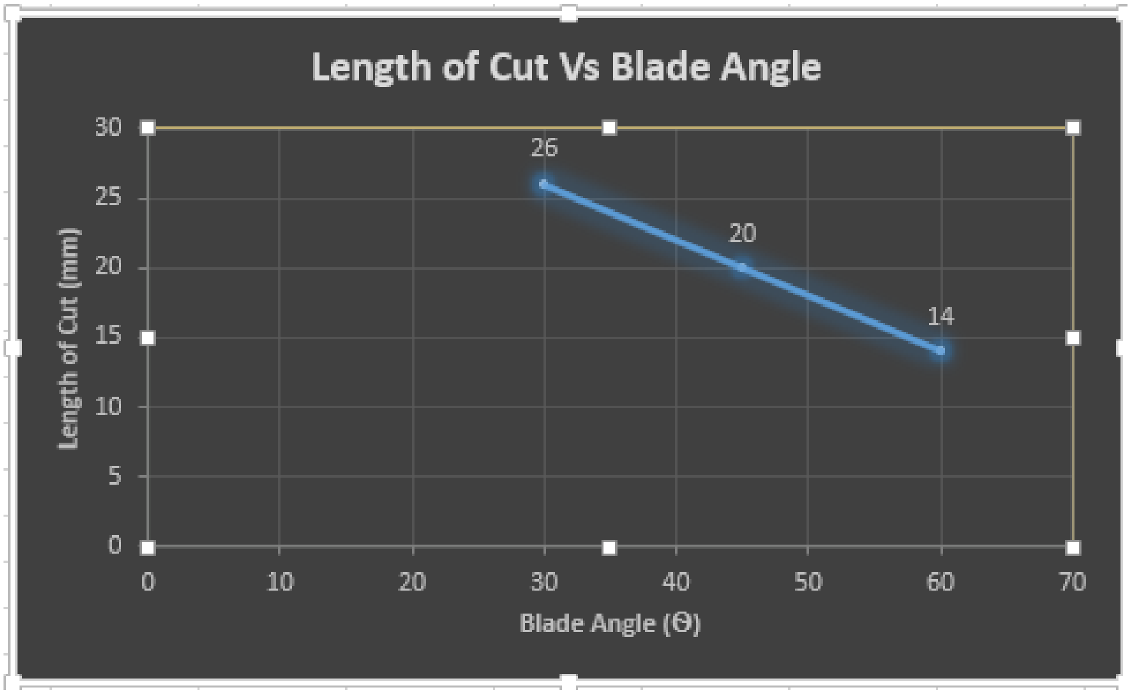



Fig. 5.6 Length of Cut at angles of 30°, 45° and 60°

It can be clearly seen than at 60 degree the length of cut is 14 mm which is suitable for animal husbandry.

## 5.7 Behaviour of residual error with number of iterations:

As we increase the number of iterations, the residual error will be decreased.

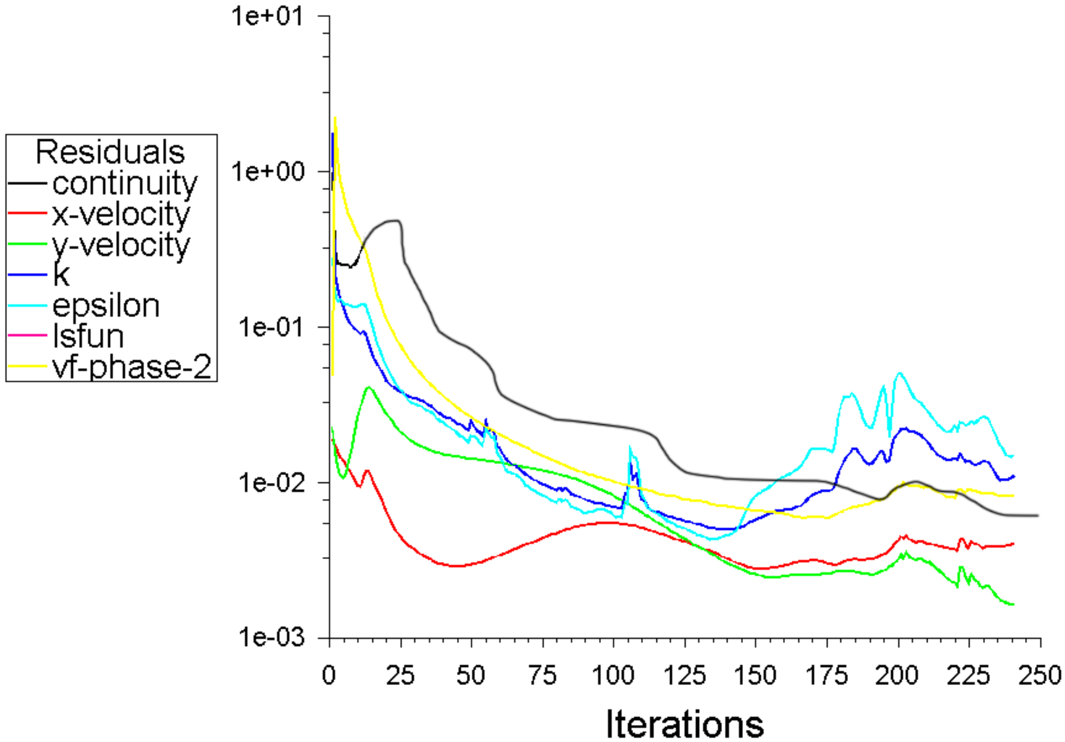



Fig. 5.7 Behaviour of Residual errors with the increase of Iterations

## 5.8 Conclusion:

- Standard diameters for larger and smaller pulleys are 100 and 224 mm.
- Belt with specification A 1016/40 will be used. It means belt belongs to section A with nominal inside length is 1016 mm or 40 inch.
- Module for spur gear is 4mm.
- Diameters for cutting blade holder shaft and feed roller shaft are 15 and 20mm.
- After simulation, we can analyze that when we increase the cutting angle of blade then the length of cut decreases.
- Moreover, as we increase the iterations, the residual error will be decreased.

## 5.9 References: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