Design and Fabrication of Agricultural Crop Reaper

Shravan U. Burade[1], Rohit S. Ghatule[2], Varad G. Kannadkar[3], Neel V. Sonawane[4]

[1,2,3,4] *Student, Department of Mechanical Engineering, NBN Sinhgad School of Engg; Pune-41, Maharashtra, India*

Abstract - *This machine targets the small scale farmers who have land area of less than 2 acres. This machine is compact and can cut up to two rows of plant. It has cutting blades which cut the crop in a scissoring type of motion. There are no is cutter on two metal strip (plate) upper cutter plate will be reciprocate by scotch yoke mechanism. It runs on electrical AC motor with 1Hp capacity, this power from motor, is provided through pulley and gear box arrangement to the cutter. A collecting mechanism is provided for the collection of crops to one side after cutting. This mechanism is also powered by pulley arrangement, two sprockets and chain arrangements given for collection of crops. This compact harvester is manufactured using locally available spare parts and thus, it is easily maintainable. This harvester might be the solution to the problems faced by a small scale farmer regarding cost and labor implementation. After testing this machine in farm it is found that the cost of harvesting using this harvester is considerably less as compare to manual harvesting.*

***Key Words* - Crop Reaper, Harvesting, Scissoring motion, Collecting mechanism, Field, etc.**

1. INTRODUCTION

Farming is most widely followed profession in India. Agricultural products contribute a major portion to our economy. Engineering science has brought tremendous changes in traditional methods of agriculture viz. sowing, planting, irrigation, fertilizer spraying, harvesting, etc. However to increase our economic condition, we must increase the productivity and quality of our farming activities. Nowadays very few skilled labors are available for agriculture. Because of this shortage the farmers prefer to use reaper harvesters.

These reapers are costly and only available of very large scale farming. However, agriculture groups make these available for rent on an hourly basis. But the small holding farm owners generally do not require the full-featured combine harvesters. Also, these combine harvesters are not available in all parts of rural India due to financial or transportation reasons. Thus, there is a need for a smaller and efficient combine reaper which would be more accessible and also considerably cheaper. The mission is to create a portable, user-friendly and low cost mini harvester taking into account the requirements of current situation; the idea was created to prepare a machine which is cheap and will reduce the labor required to cut crops. This machine has the capability and the economic value for fulfilling the needs of farmers having small land holdings. This machine is cost effective and easy to maintain and repair for the farmers. The machine model is designed based on the demand for a compact and economical reaper. This demand is taken into consideration by consulting farmers in person, for their problems and requirements. Taking into account the present scenario of corn harvesting we decided to prepare a model of corn reaper with compact construction which will be mostly suitable for farmers having small and for agriculture. The machine prototype will be economical and most convenient for cutting corn stalks and other similar plants having same or less shear strength than corn. Harvesting is the process of gathering a ripe crop from the fields. Reaping is the cutting of grain or pulse for harvest, typically using a scythe, sickle, or reaper. Process automation has increased the efficiency of both the seeding and harvesting process.

1.1 Problem Statement

1. Manual labor takes time and is not effective as they can work for 3-4 hours at a stretch.
2. Even if the land holding is small, it takes two or three days to completely harvest the crop.
3. High costs of machines and maintenance, non-availability of appropriate agricultural machines and equipment that cater to and suit the requirements of small scale farms.

1.2 Objective

1. To formulate an idea to suit our required functionality that is to reap the crops.
2. To develop the idea to suitable mechanical principles and to design the idea to practice.
3. To fabricate the design with the knowledge and the selected material which are cost effective.

1.3 Working Principle

The crop reaper is used to reap the crop like wheat, maize and rice type of crops. The crop reaper has four wheels to move and there is an engine to power the whole device. The power from the engine transfer to the v- belt drive and it goes to the center shaft. There is a bevel gear attached to the central shaft transfer power to perpendicular direction. There will be a belt drive system attached to the chain drive assembly and there is some blades present to reap the crop properly. The rotary motion of the belt drive helps to move the scotch yoke mechanism to sideway along with it the reaper blade also move to cut the crops. The completion of harvesting marks the end of the growing season, or the growing cycle for a particular crop, and the social importance of this event makes it the focus of seasonal celebrations such as harvest festivals, found in many religions. Reaping is usually distinguished from mowing, which uses similar implements, but is the traditional term for cutting grass for hay, rather than reaping cereals. The stiffer, dryer straw of the cereal plants and the greener grasses for hay usually demand different blades on the machines. The reaped grain stalks are gathered into sheaves (bunches), tied with string or with a twist of straw.

2. PRESENT METHOD

Hand reaping is done by various means, including plucking the ears of grains directly by hand, cutting the grain stalks with a sickle, cutting them with a scythe, or a scythe fitted with a grain cradle. Reaping is usually distinguished from mowing, which uses similar implements, but is the traditional term for cutting grass for hay, rather than reaping cereals.

2.1 Manual Crop Cutting:

The stiffer, dryer straw of the cereal plants and the greener grasses for hay usually demand different blades on the machines. The reaped grain stalks are gathered into sheaves (bunches), tied with string or with a twist of straw. Several sheaves are then leant against each other with the ears off the ground to dry out, forming a stood. After drying, the sheaves are gathered from the field and stacked, being placed with the ears inwards, then covered with thatch or a tarpaulin; this is called a stack or rick. In the British Isles a rick of sheaves is traditionally called a corn rick, to distinguish it from a hay rick ("corn" in British English retains its older sense of "grain" generally, not "maize"). Ricks are made in an area inaccessible to livestock, called a rick-yard or stack-yard. The corn-rick is later broken down and the sheaves threshed to separate the grain from the straw.

2.2 Crop Cutting using Machine:

To the cutting and threshing machine for seed separation this method the crop are remove as mentioned in the traditional method. These method crops are tied together to from a bundle. These bundles are garnered and taken to threshing machine. This machine separates the seed from the crops.

2.3 Combine Crop Cutting Machine:

The combination of crop cutting machine is to combine the three operations like as cutting, reaping and winnowing into a single process. The combination of crop cutting machine is the most economically labor saving.

3. METHODS AND EQUIPMENT FOR HARVESTING MAJOR CROPS:

Harvesting of crops like paddy and soybean has to be done carefully as the matured grains easily detach from the ear heads/pods and, therefore, cannot be harvested by fast working tools or machines. Bengal gram, green gram, lentils are to be harvested at ground level. Oilseed crops pose different type of problems to engineers for mechanization of their harvesting. Safflower is a spiny crop and difficult to harvest even manually. This also needs gentle handling. Farmers follow different methods for harvesting of rapeseed/mustard and pigeon pea. Mostly, farmers harvest these crops at branch level, but small farmers harvest these crops at ground level. Harvesting of root crops involves digging, shaking to remove adhering soil, windrowing or stacking and picking. A good root crop harvester should give maximum recovery and cause minimum damage to pods or tubers. The harvesting methods followed by farmers for major crops are as follows: Cereal crops Wheat and Rice: Harvesting of these crops is traditionally done by using local sickle. Improved serrated blade sickles are also in use.

The following machines are available for efficient harvesting of these crops:

i. Self-propelled walking type reaper
ii. Reaper binders
iii. Tractor front and rear mounted reapers
iv. Combine harvesters

4. LITERATURE SURVEY:

Chavan et al,. (2015) presents the project to help small-scale farmers to meet an increased demand for local grains, by designing a reaper machine to harvest grains more efficiently. Our research work will focusing on ease of harvesting operation to the small land holders for harvesting varieties of crop in less time and at low cost by considering different factors as power requirement , cost of equipment , ease of operation , field condition , time of operation and climatologically conditions. The operating, adjusting and maintaining principle are made simple for effective handling by unskilled operators.[1]

Ghumadwar and Bankar (2016) presents the concept for design and analysis of crop cutter. The crop cutting is important stage in agriculture field. Currently in India former used conventional method for crop cutting i.e. the conventional method for crop cutting is as manually cutting using labor but this method is lengthy and time consuming. This project aim is to design and analysis of small field crop cutter machine for small height crop. It helps to reduce farmer’s effort and to increase rate of cutting crop. The machine of consist of petrol engine. This machine is helpful for both the small as well as big farm.[2]

Patel et al,. (2016) presents the problem considered in this paper is on reaper and binder machine. It performs cutting and binding simultaneously. During operation in the field, we faced the problem of arm for binder which transmits the motion from the base mechanism to the fingers which collect the grass. We will carried out analysis for failure of arm and modify the design.[3]

Shivankar et al,. (2015) presents the ultimate aim of agriculture or farming in India is not only limited to growing of crops but is also associated with the economic growth of farmers and labors. Small scale farmers frequently face the problem of labour shortage or are unable to afford the wages constrained by the labours. These problems prevent the fiscal growth of farmers and ultimately hamper the development of their farmland and family. Efficient, effective, cheap and productive techniques are needed to strengthen the farmers. The project is based on developing a machine which focuses on labor problems faced by small scale farmers who have agricultural land. The machine developed can harvest up to two rows of soya bean plant at a time. The components of the machine comprise of a diesel engine of 3.5hp, pulley, a belt drive, a collecting mechanism and a cutter. The crop is being harvested by a scissoring type of motion. The power from the engine is provided to the cutter through pulley and belt arrangement. Powered by the pulley arrangement a collecting mechanism is being provided to the adjacent side of the cutter to collect the harvested crops. This machine is a simple and efficient solution to the problems faced by small scale farmers as it reduces the cost of harvesting to a considerable amount as compared to that of manual harvesting. The machine developed is small, compact and at very reasonable cost. Also, it is easy to maintain as it is made up of local spare parts which are easily available.[4]

Chakaravarthi et al. (2016) presents the machine targets the small scale farmers who have land area of less than 2 acres. This machine is compact and can cut up to two rows of soybean plant. It has cutting blades which cut the crop in a scissoring type of motion. It runs on diesel engine of 3HP, this power from engine, is provided through pulley and gear box arrangement to the cutter. A collecting mechanism is provided for the collection of crops to one side after cutting. This mechanism is also powered by pulley arrangement. This compact harvester is manufactured using locally available spare parts and thus, it is easily maintainable. This harvester might be the solution to the problems faced by a small scale farmer regarding cost and labor implementation. After testing this machine in farm it is found that the cost of harvesting using this harvester is considerably less as compare to manual harvesting.[5]

5. OPERATIONAL MECHANISM

This mechanism is used for converting rotary motion into a reciprocating motion. The inversion is obtained by fixing either the link 1 or link 3. In Fig. 5.35, link 1 is fixed. In this mechanism, when the link 2 (which corresponds to crank) rotates about B as center, the link 4 (which correspond to a frame) reciprocates. The fixed link 1 guides the frame.

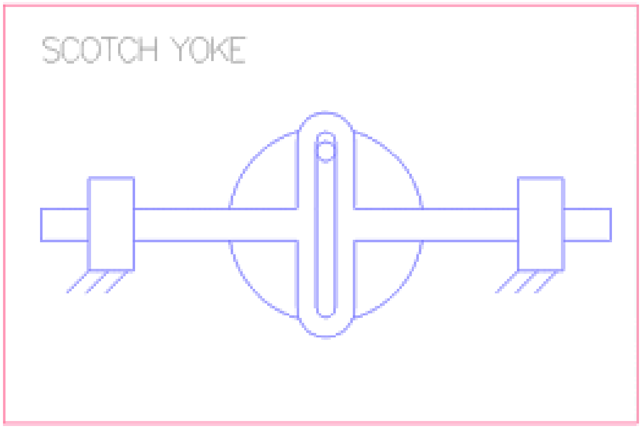

Fig-1: Scotch Yoke Mechanism

5.1Components:

Shaft: A shaft is a rotating or stationary component which is normally circular in section. A shaft is normally designed to transfer torque from a driving device to a driven device. If the shaft is rotating, it is generally transferring power and if the shaft is operating without rotary motion it is simply transmitting torque and is probably resisting the transfer of power. A shaft which is not rotating and not transferring a torque is an axel.

Mechanical components directly mounted on shafts include gears, couplings, pulleys, cams, sprockets, links and flywheels. A shaft is normally supported on bearings. The torque is normally transmitted to the mounted components using pins, splines, keys, clamping bushes, press fits, bonded joints and sometimes welded connections are used. These components can transfer torque to/from the shaft and they also affect the strength of the shaft a must therefore be considered in the design of the shaft.

Shafts are subject to combined loading including torque (shear loading), bending (tensile & compressive loading), direct shear loading, tensile loading and compressive loading. The design of a shaft must include consideration of the combined effect of all these forms of loading. The design of shafts must include an assessment of increased torque when starting up, inertial loads, fatigue loading and unstable loading when the shaft is rotating at critical speeds (whirling).

Pedestal bearing: Pedestal bearing (Pillow blocks) is also known as housings which have a bearing fitted into them. Pillow blocks are usually mounted in cleaner environments and generally are meant for lesser loads of general industry. The fundamental application of the pedestal bearing is to mount bearings safely enabling their outer ring to be stationary while allowing rotation of the inner ring. The housing is bolted to a foundation through the holes in the base. Bearing housings are of two types. They are split type or un-split type. Split type housings are two piece housings where the cap and base can be detached, while certain series are one single piece housings. Various seals are provided to prevent dust and other contaminants from entering the housing. Thus the housing provides a clean environment for the expensive bearings to freely rotate, hence increasing their performance and duty cycle. Bearing housings are usually made of grey cast iron. However various grades of metals can be used to manufacture the same.

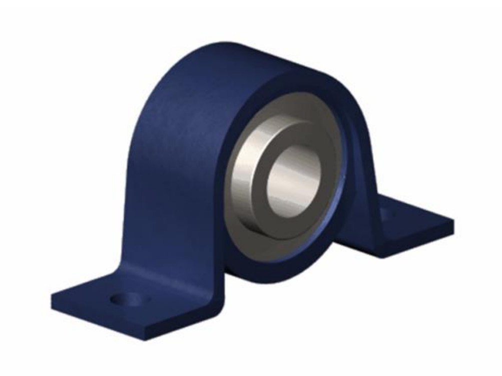

Fig-2: Pedestal bearing

V-Belt Pulley: The pulleys are used to transmit power from one shaft to another by means of flat belts, V-belts or ropes. Since the velocity ratio is the inverse ratio of the diameters of driving and driven pulleys, therefore the pulley diameters should be carefully selected in order to have a desired velocity ratio. The pulleys must be in perfect alignment in order to allow the belt to travel in a line normal to the pulley faces. The pulleys may be made of cast iron, cast steel or pressed steel, wood and paper. The cast materials should have good friction and wear characteristics. The pulleys made of pressed steel are lighter than cast pulleys, but in many cases they have lower friction and may produce excessive wear. In this, I have used a Cast Iron Pulleys.

Fig-3: V-belt pulley

V-Belt: Generally, we know that a V-belt is mostly used in factories and workshops where a great amount of power is to be transmitted from one pulley to another when the two pulleys are very near to each other. The V-belts are made of fabric and cords molded in rubber and covered with fabric and rubber as shown in Fig. below. These belts are molded to a trapezoidal shape and are made endless. These are particularly suitable for short drives. The included angle for the V-belt is usually from 30° to 40°. The power is transmitted by the wedging action between the belt and the V-groove in the pulley or sheave. The wedging action of the V-belt in the groove of the pulley results in higher forces of friction. A little consideration will show that the wedging action and the transmitted torque will be more if the groove angle of the pulley is small. But a small groove angle will require more force to pull the belt out of the groove which will result in loss of power and excessive belt wear due to friction and heat. Hence the selected groove angle is a compromise between the two. Usually the groove angles of 32° to 38° are used. A clearance must be provided at the bottom of the groove as shown in Fig. below, in order to prevent touching of the bottom as it becomes narrower from wear. The V-belt drive may be inclined at any angle with tight side either at top or bottom. In order to increase the power output, several V-belts may be operated side by side.

Fig-4: V-belt

Bevel gear: Two important concepts in gearing are pitch surface and pitch angle. The pitch surface of a gear is the imaginary toothless surface that you would have by averaging out the peaks and valleys of the individual teeth. The pitch surface of an ordinary gear is the shape of a cylinder. The pitch angle of a gear is the angle between the face of the pitch surface and the axis.

The most familiar kinds of bevel gears have pitch angles of less than 90 degrees and therefore are cone-shaped. This type of bevel gear is called external because the gear teeth point outward. The pitch surfaces of meshed external bevel gears are coaxial with the gear shafts; the apexes of the two surfaces are at the point of intersection of the shaft axes.

Bevel gears that have pitch angles of greater than ninety degrees have teeth that point inward and are called internal bevel gears. Bevel gears that have pitch angles of exactly 90 degrees have teeth that point outward parallel with the axis and resemble the points on a crown. That's why this type of bevel gear is called a crown gear.

Engine: A small engine is the general term for a wide range of small-displacement, low-powered internal combustion engines used to power lawn mowers, generators, concrete mixers and many other machines that require independent power sources.[1] Most small engines are single-cylinder, with a few V-twin units. Although much less common, there have been small Wankel (rotary) engines manufactured for use on lawn mowers and other such equipment.

The engines, which may be of two or four-stroke design, are small in both physical dimensions and power output, relative to larger automobile engines. Power output ranges from less than 1 to about 15 horsepower. The smallest of all are used in handheld garden machinery, such as string trimmers and chainsaws, which may be as small as 25 cc (2 cu in) piston displacement. The most common are four-stroke air-cooled single-cylinder engines running on either petrol or diesel

Engines for small machinery that must be hand-carried, such as string trimmers and chainsaws, are usually a two-stroke design, which is lighter for any given power output. However, two-stroke engines create a relatively large amount of air pollution and noise pollution, and so are beginning to be supplanted by four-stroke units.

Compared to modern vehicle engines, small engines are relatively simple in design. Capital cost is usually more important than fuel economy, running costs or longevity, thus encouraging simple designs.

Electric starting is available for small engines and is found primarily on high-feature garden machinery and larger generators particularly where there is already a complex electrical system and there may be a need for auto-starting on demand. However, a self-retracting rope-pull mechanism called a recoil starter is the predominant method of starting small engines; it does not require a battery to power a starter motor, nor an alternator to keep a battery charged. Before the invention of the recoil starter, a notched pulley was attached to the engine's flywheel; the operator would manually wind a rope around the pulley then jerk the rope to rotate the engine so that it would start. Another starting method briefly popular in the 1960s was the "impulse" or "wind-up" starter. These were operated by winding a heavy spring by means of a rotating crank handle equipped with a sprig clutch, then releasing the spring's tension by means of a lever or knob so that it would spin the engine. These were discontinued when safety problems became apparent: it was possible to leave the starter wound up and ready to start the engine unintentionally, even long after the crank was wound up, if the release were jarred. We used 80 cc engine which having power 3971.69 W.

Assembly Cutter assembly consist of a sliding cutter plate and a stationery cutter plate. The cutters used are of triangular shape. In sliding cutter plate, cutter blade is riveted on 3 mm plate and in stationery cutter plate; cutter blade is riveted on 5 mm plate. The stationary cutter plate can be directly bolted and fixed on frame. Sliding cutter blade is provided with 2 slots of 80 mm on its ends; it allows sliding motion to be in straight line.

6. CONCEPT DESIGN AND CALCULATED VALUES

6.1 Design:

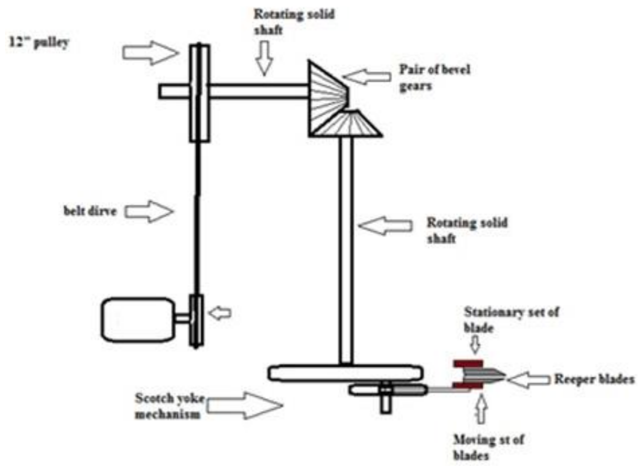

Fig-5: 2D design model of actual mechanism

6.2 Calculated Values:

Sr. No.	Component	Value
1.	Engine output	3000 rpm
2.	Dia. of both bevel shaft	20 mm
3.	Dia. of 1st pulley	101.6 mm
4.	Dia. of 2nd pulley	254 mm
5.	1st Resultant RPM	1200 rpm
6.	Teeth of 1st bevel gear	Z_1= 10
7.	Teeth of 2nd bevel gear	Z_2= 16
8.	2nd Resultant RPM	750 rpm
9.	Torque at end of 2nd shaft	28.495 Nm
10.	Cutting force at end blades	375 N

Table -1: Derived values with 1.5 FOS

7. CAD Model

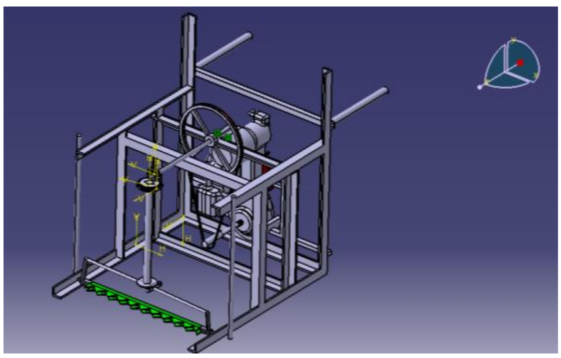

Fig -6: CAD model (Catia)

8. ANALYSIS

8.1 Bevel

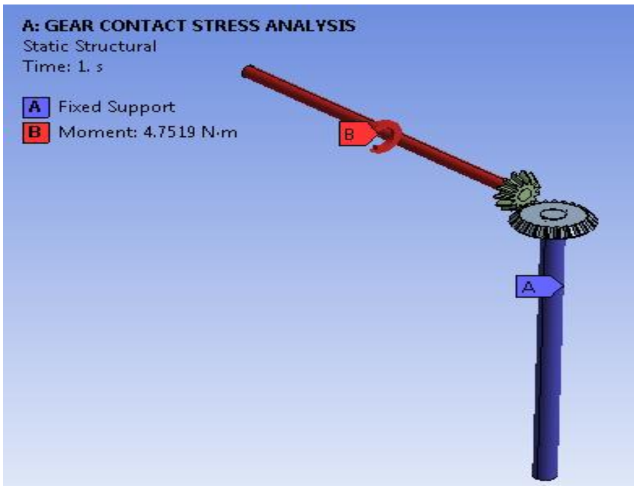

Fig -7: Static structural

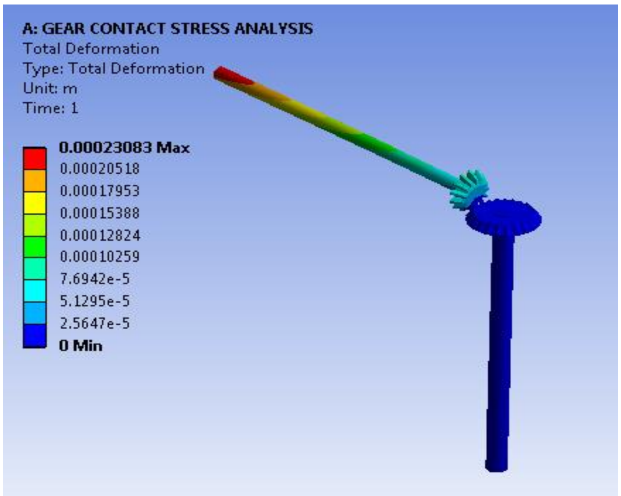

Fig -8: Total deformation

8.2 Pulley

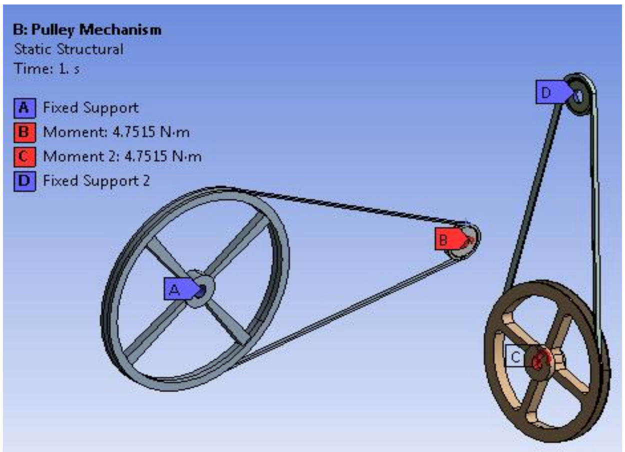

Fig -9: Static structural

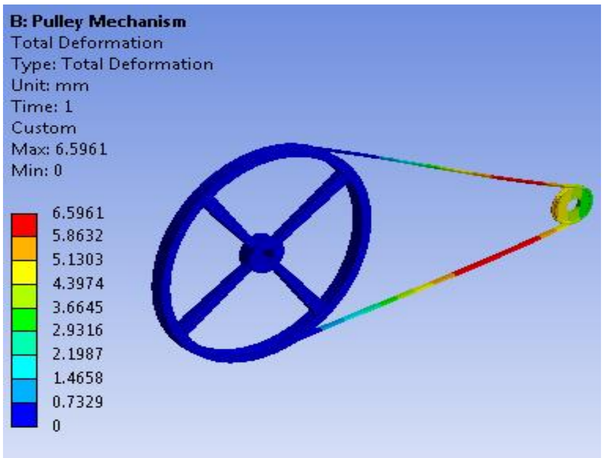

Fig-10: Total deformation

8.3 Blade

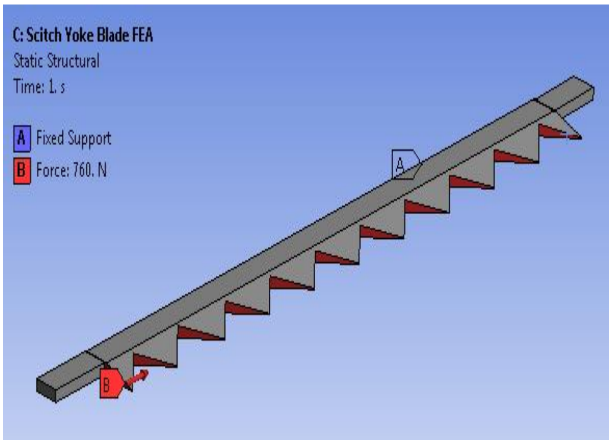

Fig-11: Static structural

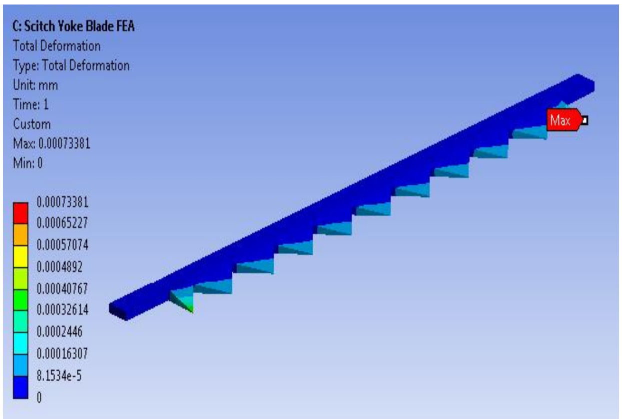

Fig-12: Total deformation

9. CONCLUSION

1. This machine can be used to trim heavy crops like corn and sugarcane.
2. Machine also can be automatically driven with the help of engine so can be use in vast trimming.

3. The cost of harvesting using this machine is considerably less as compare to manual harvesting.

4. Poor farmers can easily afford this economical crop reaper.

ACKNOWLEDGEMENT

It gives us an immense pleasure to submit this project report on 'Design and Fabrication of Agricultural Crop Reaper'. I tried my level best to present this topic into compact and to the point framework.

I wish to express my sincere thanks with profound gratitude to my guide, Prof. G. Suryawanshi and Prof. R. Nanwatkar for his valuable guidance and constant encouragement without which it would have been impossible for me to present and complete this seminar successfully. I would like to extend my sincere and true thanks to my HOD Prof. M. M. Joshi for the facilities provided to me. I thank all teachers and staff members of the department for the cooperation extended to me.

I am extremely grateful to Principal Dr. Y. P. Reddy, that he had also supported us for presenting the seminar successfully.

Let me not forget to thank all my friends for their assistance and help. It is my pleasant privilege to express my sincere gratitude to my beloved parents, without their blessings I would not be here at this stage of my life. Above all, I thank Almighty for everything I have received in my life. Apologies to those whose help is not acknowledged.

REFERENCES

[1] Design and Development of manually Operated Reaper, P.B.Chavan, D .K. Patil, D .S. Dhondge, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 12, Issue 3 Ver. I (May. - Jun. 2015), PP152

[2] Design and analysis of crop cutter, R. A. Ghumadwar, MR. V. H. Bankar, International journal of pure and applied research in engineering and technology, ISSN: 2319-507X, 2016; Volume 4 (9): 242-246

[3] A Review: Design and Analysis of Arm of Reaper and Binder Machine, Tejaskumar Patel, Chetan Vora and Vipulkumar Rokad, International Journal for Scientific Research & Development, Vol. 4, Issue 01, 2016 | ISSN (online): 2321-0613

[4] Design and fabrication of crop reaper, Shalini P. Shivankar, Ashish. M. Wankhade, Mansur. N. Syed, International journal for engineering applications and Technology, ISSN: 2321-8134

[5] Design and performance analysis of handy harvester, P. Chakaravarthi, Abuthaker. A, Arun. S, Karthikeyan. U, Vol-2 Issue-2 2016 IJARIIE-ISSN (O)-2395-4396

BIOGRAPHIES

Name: Shravan U. Burade, Student of BE-MECH final year, NBN Sinhgad School of Engg, Pune-41

Experience: Internship done in Ural Federal University, Yekaterinburg, Russia. (Design of Overhead Cranes)

Name: Rohit S. Ghatule, Student of BE-MECH final year, NBN Sinhgad School of Engg, Pune-41

Name: Varad G. Kannadkar, Student of BE-MECH final year, NBN Sinhgad School of Engg, Pune-41

Name: Neel V. Sonawane, Student of BE-MECH final year, NBN Sinhgad School of Engg, Pune-41