Design And Analysis of Reversible Plough

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Abstract- *Agriculture and the use of ploughing tools have been very important for the civilization for thousands of years. However, many changes took place in the field of ploughing during the last 30 years. About 54% of Lithuania is covered by agricultural land, therefore development and production of agricultural equipment is very important. The research object of this paper is the block of plough manufactured in joint stock company "Gamega ir Ko" in Lithuania. Main failures of these products are of mechanical nature: fractures, cracks, sags and other deformations of structural parts. The most important factors for the users of ploughs are strength and endurance properties, reliability, easy maintenance and repair. Purpose of this work was to develop a solid model of the plough using finite element method with subsequent analysis of the ploughing process including stress calculations at different workloads, thereby allowing prediction of crack generation when the plough hits the hidden stone or other obstacle in the soil.*

Keywords- block of the plough, stresses, deformation, strength, safety factor, ANSYS Workbench

I. INTRODUCTION

Agriculture has experienced tremendous changes during the second part of the 20th century. Numerous technological and scientific developments during the post-war period have been widely adopted by farmers in developed countries to boost farm productivity and move agriculture from a subsistence activity to a globalized industry. Chemicals use has been one of the major changes, with a widespread utilization of pesticides to control crop pests and commercial fertilizers to balance crop nutrient inputs. Methods of doing field operations have changed, too. In North America, the last two decades saw the gradual replacement of conventional moldboard ploughing with new conservation techniques such as no-tillage and minimum-tillage using chisel ploughs and discs. Europe is also experiencing a change of tillage practices, albeit at a slower pace than in North America. Many agronomists and machinery specialists have seen in this trend the potential extinction of ploughing as a tillage operation. There are many factors that make ploughing less attractive in comparison to conservation practices: high fuel cost, relatively slow work rate, high tractive force required, etc.

Furthermore, ploughing is often blamed as one of the main causes of soil erosion; this results from the minimal amount of crop residue left at the surface. Although these concerns are totally justified, it is important to make some distinctions based on regional differences. Conservation practices are particularly well adapted to climates where large amounts of crop residue do not impede natural soil drying and warming; these dry and warm climates are mostly prevalent in the American Midwest, the Canadian Prairies, Argentina, Brazil, South Africa and Australia. However, many other important arable regions such as most of Europe and North Eastern North America experience high rainfalls and have relatively short growing seasons. In these cases, ploughing can be beneficial as part of a diversified tillage system.

ROLLOVER PLOUGH CONCEPT

The concept of rollover plough originates from Europe, where it has supplanted the tradition alone-way plough many years ago. There are many advantages to the use of a rollover plough over a conventional plough: it allows for more efficient operation in the field, it helps maintain fields well leveled and it has a better penetration capability. These positive points all contributed to the increasing interest in this type of machine, despite the higher price tag.

To activate the rollover mechanism, two different methods are can be used: the most common system consists of a pair of hydraulic rams that work in succession to move the plough; the other system, used on the reference Grégoire-Besson SP/SPL plough range consists of a rack-and pinion system. Two 150 mm hydraulic rams move a rack and convert this linear movement to a rotational movement using a pinion.

PROBLEM STATEMENT

The Grégoire-Besson SP/SPL plough range was originally developed in the early 1980's; it wasdesigned to handle 4 to 6 furrows and tractors up to 135 kW (180 hp) (Thirouin, 2002).

However, needs have changed over time and the chassis was modified to accommodate additional furrows, new rock protection systems and various options such as coulters, trash boards, etc.

The SP/SPL plough range is suffering from many problems related to the positioning of the transport wheel on the frame. Of these problems, the main one is the lack of torque to complete the rollover process; the position of the wheel and axis of rotation is too far from the center of gravity of the plough. All the optional equipment's that are added to the frame also contribute to increasing the rollover torque. Also, damp conditions can emphasize the problem as soil sticks to the moldboards and crop residue accumulate around the shanks (Thirouin, 2000).

Another impact of the positioning of the wheel is the behavior of the plough in wet and hard soils. Many Canadian customers report that in very difficult conditions the tractor has very little control over the plough (Thirouin, 2000; Grégoire-Besson, 2004). This is mostly due to the positioning of the line of traction; a possible solution may be to put the wheel closer to the center of gravity.

Many users mentioned that one of the weakest points in the machine design is that the Z-frame can interfere with the wheel during the turnover process if the rear of the plough is not raised first ("Vive la difference", 2008; Thirouin, 2002). However, raising the backend to leave clearance for the Z-frame makes the plough unstable during turnover and increases the stress on the tractor linkage (Thirouin, 2002). Poor soil conditions on the headlands, such as ruts and holes, can also cause instability.

A design constraint also causes issues to customers who want to have a larger wheel to improve maneuverability: the current positioning of the wheel in the Z-frame limits tire diameter to less than 1100 mm. Many users would like to use 24R20.5 flotation tires (Ø1260 mm); this requires a repositioning of the wheel.

Finally, another issue with the current design is that with its current positioning, the rear wheel acts as a pivot point on the plough frame. When the tractor hitch is raised due to uneven terrain or when exiting a furrow, the plough pivots about the wheel and the bodies behind the wheel go deeper. In very wet soil conditions as encountered in Eastern North America, having a single on-land wheel is problematic as it sinks in mud, thus increasing the working depth at the back. Both of these conditions lead to an uneven work depth and quality. A current user (Mr. Gerard Steenbok) and a potential buyer (Mr. Warren Schneckenburger) of SP series ploughs gave me their opinion on the current product and suggested some improvements. Mr. Schneckenburger (personal communication, January 2008) suggests that the plough should have two wheels at the back: one in the furrow and one on land. This would allow a better depth control in wet soil conditions as the furrow wheel will be on hard soil.

PRIMARY TILLAGE

The initial major soil working operation designed to plough the soil deeply to reduce soil strength, cover plant materials and rearrange aggregates is called primary tillage. Objectives of primary tillage

a. To reduce soil strength
b. To rearrange aggregates
c. To cover plant materials and burry weeds
d. To kill insects and pests

The implements used for primary tillage are called as primary tillage implements. They include many animal drawn and tractor drawn implements. Animal drawn implements mostly include indigenous ploughs and mould board ploughs. Tractor drawn implements include mould board ploughs, disc ploughs, heavy duty disk harrows, subsoil ploughs, chisel ploughs and other similar implements.

PLOUGH

The main implement used for primary tillage is a plough. Plugging essentially consists of opening the upper crust of the soil, breaking the clods and making the soil suitable for sowing seeds. The purpose of plugging can be summarized as follows

- To obtain a deep seed bed of good texture.
- To increase the water holding capacity of the soil.
- To improve soil aeration.
- To destroy weeds and grasses.
- To destroy insects and pests.
- To prevent soil erosion and
- To add fertility to the soil by covering vegetation.

Classification of ploughs according to power used

Bullock drawn ploughs indigenous types

i) Walking type

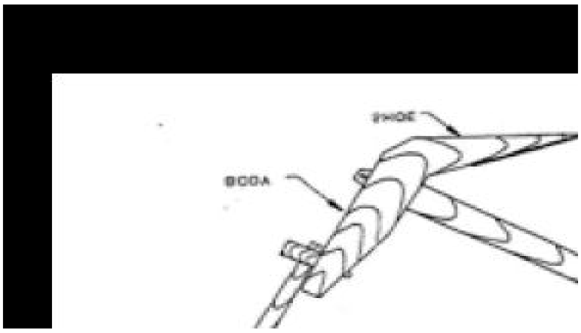
Short beam
Long beam

ii) Riding type

Tractor drawn ploughs
mounted type
Semi mounted type

INDIGENOUS PLOUGH

It is an animal drawn plough. It penetrates into the soil and breaks it open. It forms V shaped furrows with 1520 cm top width and 1215 cm depth. It can be used for plugging in dry land, garden land and wetlands. The size of the plough is represented by the width of the body and the field capacity is around 0.4 ha per day of 8 hours. The functional components include share, body, shoe, handle and beam. Except share all other parts are made up of wood. In villages local artisans make the plough and supply to the farmers. These ploughs are also called as country ploughs.



Indigenous plough

INDIGENOUS PLOUGH NOMENCLATURE:

Share: It is the working part of the plough attached to the shoe with which it penetrates into the soil and breaks it open.
Shoe: It supports and stabilizes the plough at the required depth.

Body: It is the main part of the plough to which the shoe, beam and handle are attached. In country ploughs both body and shoe are made in a single piece of wood.

Beam: It is a long wooden piece, which connects the main body of the plough to the yoke. Handle A wooden piece vertically attached to the body to enable the operator to control the plough while it is working In each state farmers use indigenous ploughs of their own make.

Operational adjustments

a. Lowering or raising the free end of the beam with respect to the plough body results in an increase or decrease in the share angle with respect to the horizontal surface which in turn increase or decrease the depth of plugging.

b. Changing the length of the beam between plough body and yoke of the animals will also alter the depth of plugging. Reducing the beam length will decrease the depth of cut and vice versa.

MOULD BOARD PLOUGH

Mould board plough is one of the oldest of all agricultural implements and is generally considered to be the important tillage implement. Plugging accounts for more traction energy than any other field operation. Mould board ploughs are available for animals, power tiller and tractor operation. While working, a mould board plough does four jobs namely

a) Cutting the furrow slice
b) Lifting the furrow slice
c) Inverting the furrow slice and
d) Pulverizing the furrow slice

Components of a mould board plough

An animal drawn mould board plough consists of

a) Plough bottom
b) Beam and
c) Hitch bracket or clevis.

A tractor drawn mould board plough consists of

a) Plough bottom
b) Beam or standard
c) Main frame and
d) Hitch frame

A) Plough bottom – The part of the plough which actually cuts, lifts, pulverizes and through the soil out of the furrow. It is composed of those parts necessary for the rigid structure required to cut, lift, turn, and invert the soil. Parts of the mould board plough bottom are

a) Share
b) Mould board
c) Land side
d) Frog and
e) Tail piece.

Share, landside, mould board are bolted to the frog which is an irregular piece of cast iron.

DESIGN OBJECTIVES, SPECIFICATIONS AND REQUIREMENTS

The selected solution to solve the problems stated in the previous section is to develop a new wheel assembly concept that comprises two wheels, one of which operates in the furrow and the other one operating on land.

In order to design the new wheel assembly appropriately, an extensive list of design specifications and requirements was established. These specifications are the basis for all the subsequent design work and decisions. They are based on future use, technical capabilities and manufacturing processes.

1. Design life: no less than 105 work cycles (rollover and lift/lower) Design life must be approximately equivalent to 500 hours of work per year (1500 ha/year) for a period of 10 years. This is a rather extreme scenario, but it takes into account the heavy use made of this type of machine in large agricultural operations in Russia and the Community of Independent States (CIS), which are two target markets for the revised SP range.

2. Modularity of design Wheel assembly: design must allow for easy upgrading of components or expansion of plough (adding one or two furrows for example). To achieve this, all connections with the existing plough frame must be bolted.

3. Easy of maintenance: The number of maintenance points must be kept to a minimum or, alternatively, the maintenance interval must be extended (i.e. seasonal or weekly greasing vs. daily or every 10 hours).

4. Maximize components commonality with other models or product ranges: This allows reducing production cost, simplifying manufacturing operations and improving access to spare parts for customers.

5. Hydraulic components adaptability: It must be possible to replace easily hydraulic components to fit different markets (i.e. Europe vs. North America).

6. Possibility of fitting high floatation tires: Design must allow fitting tires up to Ø1260 mm (24R20.5) with sufficient clearance.

7. Sufficient rollover capacity: The capacity of the rollover mechanism must offer sufficient torque reserve for a fully equipped 8 furrows plough.

8. Sufficient ground clearance and working depth: Ground clearance must be at least 300 mm and maximum work depth must be at least 250 mm with 24R20.5 tires.

9. On land wheel must have a minimal footprint: European markets require ploughs that can work very close to ditches and hedges; therefore the on land wheel must work as close as possible to the last furrow.

DESIGN APPROACH

The optimal design solution for the wheel assembly consists of independently controlled wheels installed on a cross beam. The new design does not make use of the current SP/SPL frame (fig. 10); the beefier SPS series frame is used. Using this new frame allows to eliminate the need for a traction bar that goes to the wheels: it is connected behind the third furrow (fig. 11)

Figure 10: Grégoire-Besson SPP9 plough viewed from above (Thirouin, 2008).

Figure 11: Grégoire-Besson SPSP9 plough.

To meet the need for a modular chassis, the method of connection between the plough frame and the wheel assembly will be a bolted joint. The SPS plough frame consists of a 180 mm x 180 mm and a 150 mm x 150 mm tubes welded together (fig. 13). For the new connection, a 20 mm thick flange is welded on the tube assembly; the flange has 16 holes (Ø 20 mm). This part is a standard part already used elsewhere on the frame, and consequently it does not require redesign or modifications. This flange plate mates with another flange which is welded to a 200 mm x 300 mm tube. In the current design, the tube is cut at an angle of 19.33º (equivalent to 400 mm per furrow and 1140 mm front to rear clearance between shanks); it is possible to install pivot pin at this location the case of a Variwidth plough; although this alternative was not investigated due to time limitations. Following the angled tube, another 200 mm x 300 mm tube is bolted using the same flange system. This straight tube has for main goal to provide the necessary clearance for the last shank when it hits an obstacle. Finally at the end of the beam assembly is a 32 mm thick circular plate welded onto a flange plate. This plate is where the rollover shaft connects to the plough chassis.

II. LITERATURE REVIEW

The most fundamental operations in global agricultural system are tillage and are very vital from crop production point of view. During the past centuries, the soil cultivation is brought about by plugging especially with moldboard plough. Its dual functions of cultivation and soil inversion make it very popular among the farming communities especially to control weeds. The recent economic and environmental concerns have compelled the farming community to reconsider the use of tillage operations and if possible, implement alternative technologies for soil cultivation. Energy consumption and the working efficiency are the basic parameters to assess the performance of the implement.

SOIL TILLAGE

Lal (1993) defined soil tillage a tool to improve the soil quality and its capacity to perform economic, ecological and aesthetic function (Lal, 1990; Deere and Company, 1976). The non judicious tillage operations by the farmers in South and South East Asia have resulted in various soil problems (Lal, 1990). Soil tillage may be defined as physical or mechanical manipulation of soil to modify soil conditions for the purpose of crop production by providing conducive environment for seed germinations and root development, suppressing weed, controlling soil erosion, increasing infiltration and reducing evaporation of soil moisture (Prihar, 1990).

TILLAGE SYSTEMS

A diverse range of tillage systems are being practiced throughout the world. This affects the distribution and location of crop residues left behind after harvest. The following tillage systems are the most common practiced by farmers.

No-tillage or Zero tillage

In this tillage system, the soil is left undisturbed except for seed or nutrient placement. The use of herbicides has led to the adoption of no-tillage (NT) or zero tillage (ZT). The minimum soil disturbance is achieved with special equipments like coulters, row cleaners and tine openers.

Conventional tillage

Conventional tillage or intensive tillage system includes all tillage practices that leave < 15% of residues on soil surface. Moldboard plow and other secondary tillage implements are used, especially in clayey soils with drainage problems. Conventional tillage operations pose some serious concerns e.g. high fuel and time requirements, soil compaction and deterioration in soil structure. The high fuel cost (in energy conscious world) necessitates the use of alternate tillage systems with less chances of erosion (Mitchell *et al*., 2009).

Minimum or reduced tillage

According to Lal (1999), any tillage system that leaves 15-30% of residue cover after planting is supposed to be minimum tillage. The minimum or reduced tillage (MT or RT) system reduces the chances of soil crusting and soil erosion because of less soil disturbance (Lal, 1997).

Conservation Tillage

Any tillage system that leaves >30% of crop residues on the soil surface comes under the category of conservation tillage (as defined by the *Conservation Tillage Information Center*, CTIC). The conservation tillage system is a generic term used to describe the soil and water losses due to conventional tillage practices (Mannering and Fenster, 1983). The conservation tillage is basically collection of many tillage types with the objective of crop residue management.

Ridge tillage

Ridge tillage is a system where the soil is not disturbed from planting to harvest except for nutrient application and the crop planting is accomplished on the ridges with disk openers, cleaners, sweeps, coulters and/or row cleaners. The crop residues are retained between ridges on the soil surface.

Deep tillage

Deep tillage aims to break the hardpan or plough pan formed under the plough layer due to repeated tillage or traffic to increase the root penetration and water infiltration.

TILLAGE SYSTEMS AND SOIL TYPE

The workability of soil largely depends on soil type. Light or sandy soils are easy to work at all moisture levels. Although the water storage in these soils is low, water conduction and infiltration is high. This may be dangerous with respect to salt residue. The light soils have low heat capacity, reducing the organic matter content rapidly. Typically, the nutrients and humus contents are low. The medium texture soils (silty and loamy soils) are considered the most beneficial agricultural soils because of their ability to hold enough water for plant growth and ample aeration. The nutrient content of these soils is comparatively high. The workable limit of these soils is much wider than the clayey or heavy soils, and they produce good crop yield. On the other hand, the clay soils or heavy soils are difficult to plough because the soil is hard enough at low moisture and tillage operations are almost impractical. High moisture contents in heavy soils cause plasticization and crumbling and require very high draft forces for tillage implements. These soils can be worked in a limited range of moisture contents. The water conductivity is low because of high proportion of microspores and insufficient aeration. High water holding capacity, combined with cycles of drying and swelling may cause cracking. The uses of minimum tillage and/or direct drilling depend largely on the selected crop species and soil type under set of climatic conditions. The soil texture has profound effects on soil workability. The coarser the soil less is the water holding capacity, more rate of water percolation and hence low nutrient retention for sustainable crop yield. The great resistance is attributed to fine soils because their manipulation is very difficult and have low rate of water infiltration. The medium soils are the most advantageous for better crop growth because of good water holding capacity, aeration and drainage. Soil physical properties affecting seed germination, seedling emergence, establishment of crop stand and crop yield are subjected to change by tillage operations. Efforts are needed to optimize tillage system capable of coping the drawbacks of all existing practices.

TILLAGE INDUCED EFFECTS ON SOIL PHYSICAL CHARACTERISTICS

The physical soil characteristics are those that can be seen and/or felt. The soil physical characters are of utmost importance for crop production. The physical properties are of permanent nature and usually difficult to change, compared to soil chemical properties. The soil physical properties are affected by the tillage operations carried out and tillage implements used. Tillage operations increase soil porosity by its loosening and reduce bulk density and mechanical impedance (Pidgeon and Some, 1978; Rizvi *et al*., 1987). The knowledge of relationships between different soil physical properties is necessary for the evaluation of the possible consequences of tillage practices on soil conditions and crop production. The changes in soil physical characteristics induced by tillage may persist for varying lengths in various soil types (Busscher *et al*., 1986) and is strongly related to climatic conditions. The deterioration of soil structure as a result of continuous cropping can affect crop growth adversely. The choice of suitable tillage systems will be useful to control soil degradation.

Both adverse and beneficial effects occur as a consequence of intensive tillage. The adverse effects include soil compaction (Soane *et al*., 1982), soil erosion (Kaiser, 1967), loss of soil organic matter (Unger, 1982) and ultimately destruction of internal drainage (Coote and Ramsey, 1983). The possible beneficial effects include increased water conductivity into soil profile through macro pores in minimum tillage systems (Lindstrom *et al*., 1984), and soil organic matter stabilization in certain tillage and residue management systems (Unger, 1982). Results of 50 years of minimum tillage (Pikul and Allmaras, 1986) showed that residue management had altered certain soil quality (physical and chemical) parameters. The protection of soil erosion and soil moisture conservation for crops should be major objectives of conservation tillage (Allen and Fenster, 1986).

Soil moisture content

The tillage systems in relation with soil water contents and cropping system require systematic analysis under field conditions (Shafiq, 1993). The economic analysis of tillage operations and cropping systems may lead towards the development of cost effective technology for sustainable crop production. The possible effects of tillage methods on crop yield in dry regions are attributed to the differences in soil water regimes (Chevalier and Chiha, 1986). Greater soil moisture contents under NT than those for CT have been observed (Power and Maskina, 1990). The higher moisture contents was attributed to reduced evaporation under NT due to presence of residue cover (Jones *et al*., 1969; Lal, 1981), increased soil infiltration (Triplett *et al*., 1968) and an overall greater water recharge in soil profile (Allmaras *et al*., 1977). Sub-soil compaction effects are more or less are associated with different tillage systems (Ishaq, 2000). Some soils are naturally compacted because of the presence of restrictive layers found in them. Similarly, secondary tillage practices and mould board plowing under conventional tillage systems pose serious threats of soil compaction. Ankeny *et al*. (1990) concluded that tillage operations performed under unfavorable climatic conditions also results in soil compaction. Clay pans present in heavy textured soils also restrict root growth. Intensive and un-necessary tillage operations cause deterioration of soil quality because of increased decomposition soil organic matter and environmental quality. Lal (1989) and Carter (1992) reported that conservation tillage practices may lead to high SOC contents in surface soil than conventional tillage system or mould board plow. Reduced or minimum tillage is highly effective practice in soil and water conservation when compared with conventional tillage systems. Improved infiltration and reduced evaporation caused more water conservation (Unger and Ordief, 1989). Radford *et al*. (1992) reported 28% more plant available water at sowing under zero tillage (ZT) system. Conservation tillage practices lead to beneficial changes in soil physical properties *e.g*. soil water content (Moreno *et al*., 1997) and aggregate stability and soil aggregation (McQuaid and Olson, 1998). Norwood (1994) related tillage system with water availability especially in years receiving low rainfall. This increased soil water availability may be attributed to the crop residues on the surface soil that reduced evaporation losses (Munawar *et al*., 1990). Lopez *et al*. (1996) concluded no-tillage is an ineffective practice to improve soil water content. This is due to the fact that soil response to tillage is highly likely on long term basis. It is, therefore necessary to conduct tillage studies under different soil, cropping and climatic conditions. Pore-size distribution and soil organic matter (SOM) content in un tilled than tilled soils may cause improved plant available soil water content and higher yields (Bescansa *et al*., 2006)

MATERIALS AND METHODS

Tractor and Instrumentation System

A fully instrumented Massy Ferguson (MF) 3090 tractor (Figure 1) was used in the study. The specifications of the tractor are presented in Table 1. The instrumentation system consisted of: (a) a drawbar dynamometer, to measure the drawbar pull (b) two wheel torque transducers, to measure the wheel forces (c) a three-point linkage-implement force and depth transducer, to measure the three-point linkage forces and depth, (d) other transducers , to monitor ground speed, fluid temperatures (engine oil, transmission oil, front axle oil, engine coolant and engine fuel), power take off (PTO) torque, right and left position of front wheel steering and angular position and indication of the lifting position of the three-point linkage, (e) a data logger, to monitor and record data from various parameters and (f) a computer, for processing and analyzing data (Al-Suhaibani et al., 2010). The draft was measured using a drawbar dynamometer (Figure 2a) consisting of two load sensing clevis bolts and the force exerted by the plow was measured by a strain gauge bridge within the clevis bolts. The tractor ground speed was measured using a fifth wheel attached to a suitable position underneath the tractor as shown in Figure 2b. An RS shaft encoder (360 pulses/revolution) was mounted on the fifth wheel and used to measure the distance traveled, and hence the actual ground speed. The depth was measured using the three point linkage-implement force and depth transducer (Figure 2c) which was developed specifically for use with mounted implement of categories II (40-100 hp) and III (80-225 hp) as specified by the ASAE standard (ASAE, 1985). A data logger mounted on a platform to the left of the tractor operator was used to scan and record the output signals from the transducers. The strain gauge transducers in the instrumentation system were connected to the data logger through amplifier boxes, which also provided a regulated power supply to give excitation to the transducer. The activity unit was used to provide excitation to both the data logger and transducers with input supply from the tractor battery (12 V). It was, also, used to indicate the activity performed during field tests. The data was displayed on a lap top computer as shown in Figure 3. **Chisel Plows** Three chisel plows of different weights, widths and number of shanks were used in this study: (a) a medium size Massy Ferguson (Denmark) chisel plow (Model MF 38, serial No. L4078) which weighed 380 Kg (3.785 kN) and had a width of 180 cm and 7 shanks distributed in 3 rows, (b) a heavy duty Mazia (Italy) chisel plow (Model CMP115-R, Serial No. 59062) which weighed 415 Kg (4.133 kN) and had a width of 315 cm and 15 shanks distributed in 2 rows and (c) a super heavy duty Galucho (Portugal) chisel plow (Model STT-15, Serial No. G 99-343-499) which weighed 680 Kg (6.773 kN) and had a width of 385 cm and 15 shanks distributed in 2 rows. The specifications of the plows are shown in Table 2. The three chisel plows are shown in Figure 4. The distributions of the shanks on the plow frames are shown in Figure 5.

Figure 1. The fully instrumented tractor

MATERIALS

The materials are taken from the engineering database of Chisel Plow production system specification drawn by Industry. The properties of Material and Soil are taken as per the following data:

Table 1. Material Properties

Material Name	Stainless Steel	
Material Properties	Density	7750 Kg/m^3
	Young's Modulus	1.93 X 10^{11}
	Poisson Ratio	0.31
	Bulk Modulus	1.693 X 10^{11}
	Shear Modulus	7.3664 X 10^{10}
	Tensile Yield Strength	207 MPa
	Compressive Yield Strength	207 MPa
	Tensile Ultimate Strength	586 Mpa

Table 2. Soil Properties

S. No.	Type of Soil	Soil Resistance (Kg/m^2)	Optimum Moisture Content (%)
1	Sandy Soil	2000	3.5
2	Sandy Loam	3000	5.8
3	Silt Loam	3500-5000	5.8
4	Clay	4000-5600	7.18
5	Heavy Loam	5000-7000	13.30

SOIL PARAMETERS

The properties of the soil related to the desired chisel plow were recognized as types of soil, wetness, mass concentration and cone index. The measurement and categorization methodologies are discussed in the subsequent section. Black type of soil is used in this research work for the chisel plow analysis. The humidity substance of soil performs a significant task for the development of the crops therefore subsequent Soil resistance and humidity substance of soil are taken as per the table 2.

III. INTRODUCTION TO SOFTWARES USED

Introduction:

CAD is used to design and develop products, which can be goods used by end consumers or intermediate goods used in other products. Cadis also extensively used in the design of tools and machinery used in the manufacturer of components. Cadis also used in the drafting and design of all types of buildings, from small residential types(house) to the largest commercial and industrial types. CAD is used thought the engineering process from the conceptual design and layout, through detailed engineering and analysis of components to definition of manufacturing methods.

INTRODUCTION TO PRO/E:

PRO/E is the industry's de facto standard 3D mechanical design suit. It is the world's leading **CAD/CAM /CAE** software, gives a broad range of integrated solutions to cover all aspects of product design and manufacturing. Much of its success can be attributed to its technology which spurs its customer's to more quickly and consistently innovate a new robust, parametric, feature based model. Because that ***PRO/E*** is unmatched in this field, in all processes, in all countries, in all kind of companies along the supply chains.***PRO/E*** is also the perfect solution for the manufacturing enterprise, with associative applications, robust responsiveness and web connectivity that make it the ideal flexible engineering solution to accelerate innovations. ***PRO/E*** provides easy to use solution tailored to the needs of small medium sized enterprises as well as large industrial corporations in all industries, consumer goods, fabrications and assembly. Electrical and electronics goods, automotive, aerospace, shipbuilding and plant design. It is user friendly solid and surface modeling can be done easily.

DESIGNED MODEL:

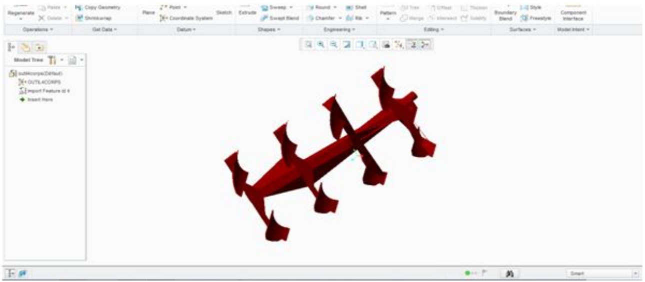


Fig: Reversible plough

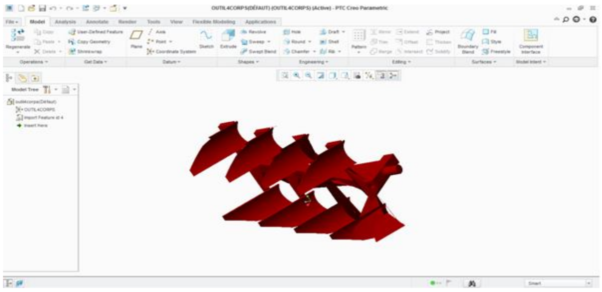


fig: Final Model

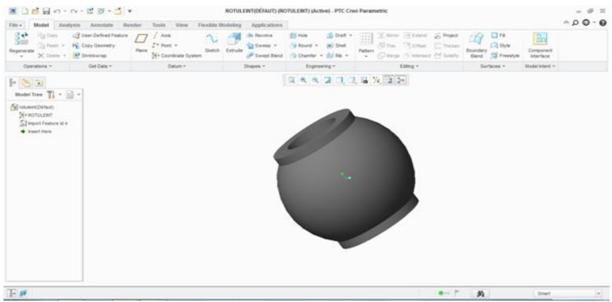


Fig: Rotuleint

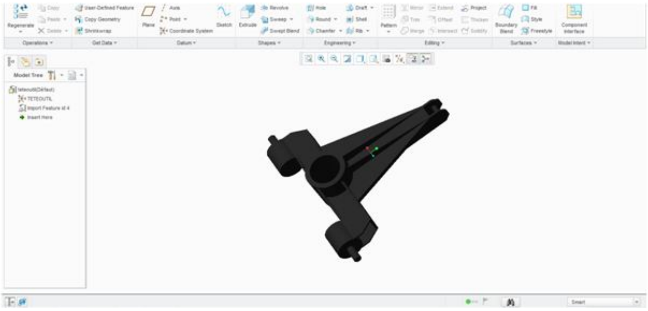


Fig: Teetotal

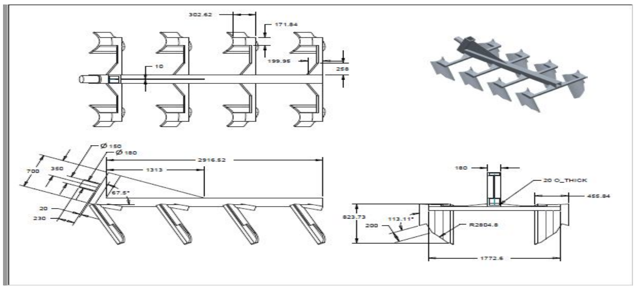


Fig: Detailed View

INTRODUCTION FEM

The finite element method is numerical analysis technique for obtaining approximate solutions to a wide variety of engineering problems. Because of its diversity and flexibility as an analysis tool, it is receiving much attention in almost every industry. In more and more engineering situations today, we find that it is necessary to obtain approximate solutions to problem rather than exact closed form solution. It is not possible to obtain analytical mathematical solutions for many engineering problems. The finite element method has become a powerful tool for the numerical solutions of a wide range of engineering problems. It has been developed simultaneously with the increasing use of the high- speed electronic digital computers and with the growing emphasis on numerical methods for engineering analysis. This method started as a generalization of the structural idea to some problems of elastic continuum problem, started in terms of different equations.

PROCEDURE:

Importing the Model:

In this step the PRO/E model is to be imported into ANSYS workbench as follows:

In utility menu file option and selecting import external geometry and open file and click on generate. To enter into simulation module click on project tab and click on new simulation

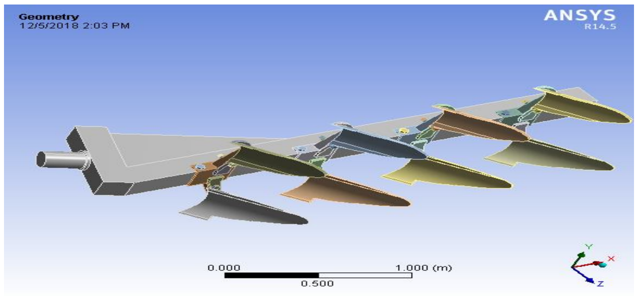


Fig: importing model

Meshing the model

To perform the meshing of the model these steps are to be followed:

Chose the main menu click on mesh- right click- insert sizing and then select geometry enter element size and then click on generate mesh.

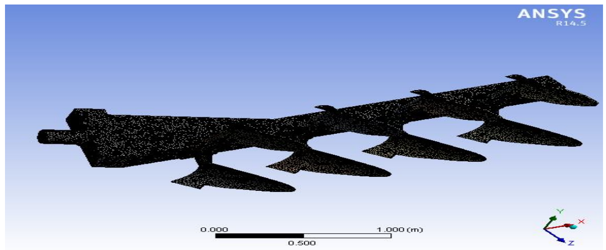


Fig: Meshing model

Applying Boundary conditions and Loads:

To apply the boundary conditions on the model these steps are to be followed:

Chose the main menu, click on new analysis tab select static structural click on face and then select face of the geometry-right click- insert-fixed support. Choose the main menu, select face and click on face of geometry- right click – insert – force

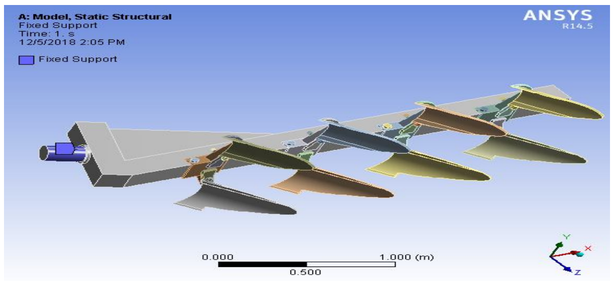


Fig: Fixed Supports

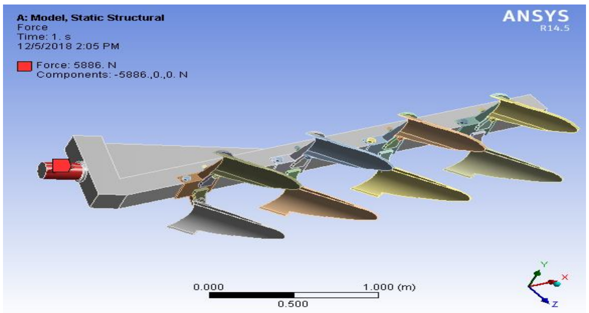


Fig: Force 1

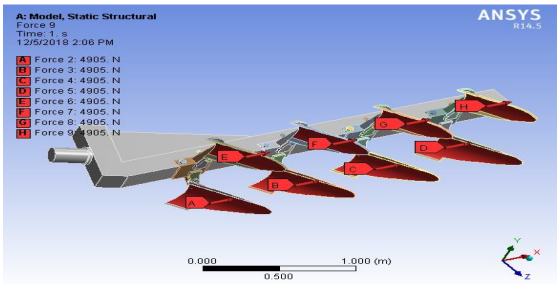


Fig: Force 2

Solving the Model:

To solve the model these steps are to be followed:

Choose the main menu, click on solution – insert – stress
Click on solution – insert – deformation – total deformation
Click on so
lution – right click – evaluate results – solve

IV. RESULTS

The main menu is chosen and then click on stress and deformation. The stresses and deformations will be displayed showing the maximum and minimum values.

Material Properties:

Material	Stainless steel	Gray Cast iron
Young's modulus	1.93e+5 Mpa	1.1e+5 Mpa
Poisson's Ratio	0.31	0.28
Density	7.75e-6 kg/mm3	7.2e-006 kg/mm3
Ultimate Tensile strength	586 Mpa	240 Mpa

Cast iron:

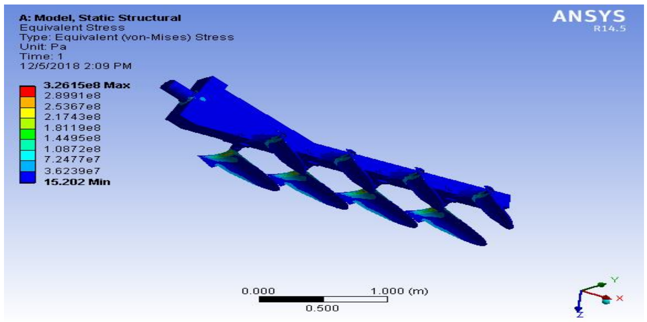


Fig: Stress

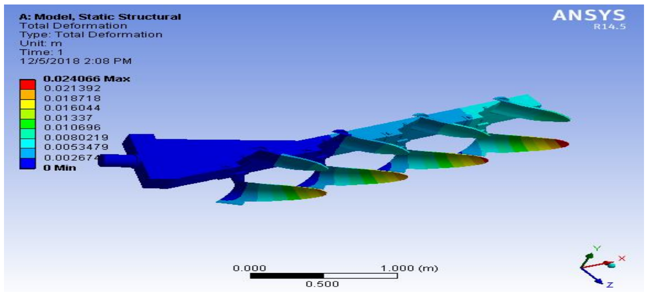


Fig: Total Deformation

Model Analysis:

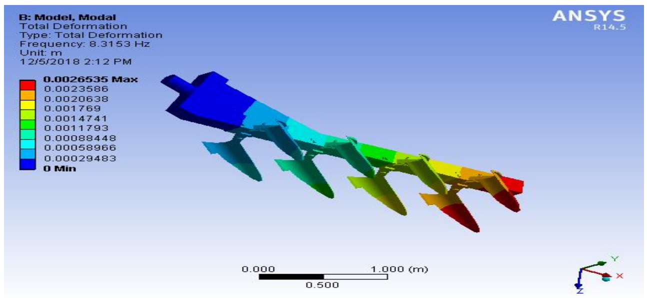


Fig: Mode1

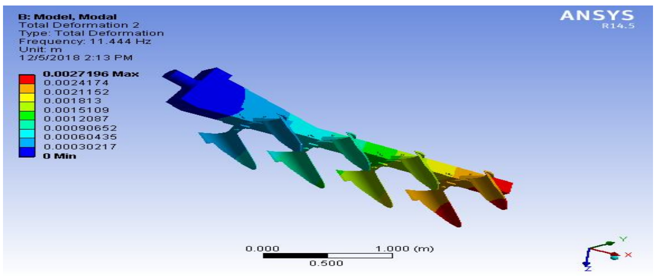


Fig: Mode 2

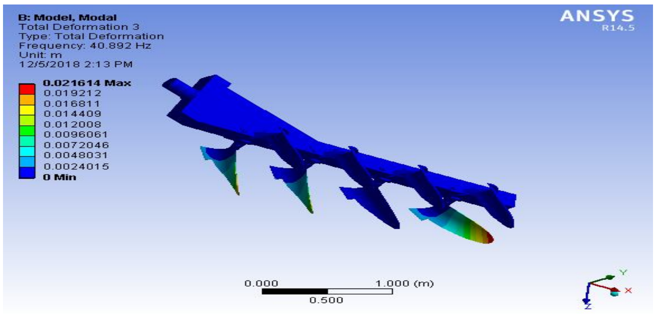


Fig: Mode 3

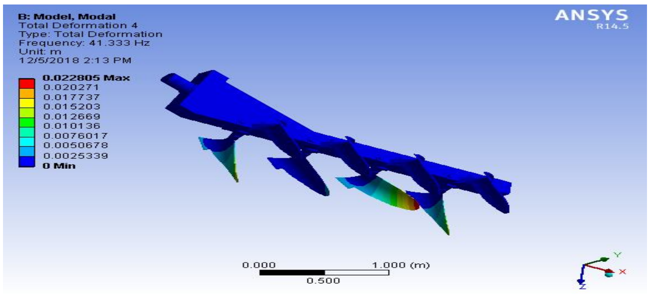


Fig: Mode 4

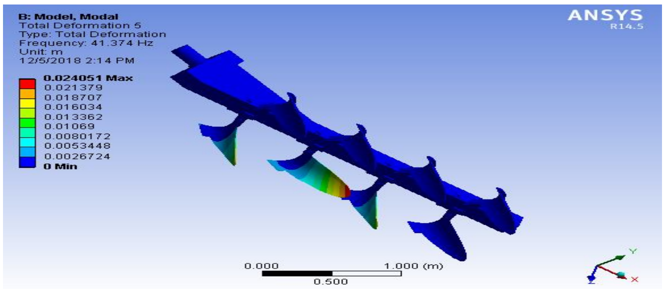


Fig: Mode 5

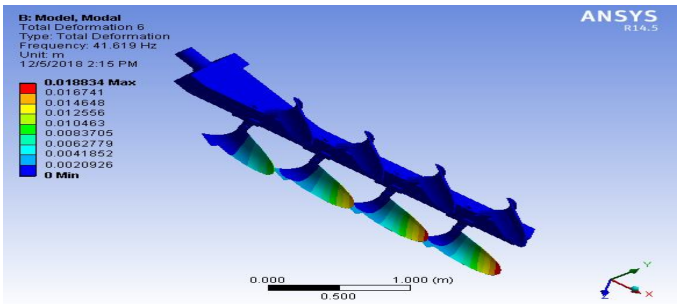


Fig: Mode 6

Stainless steel:

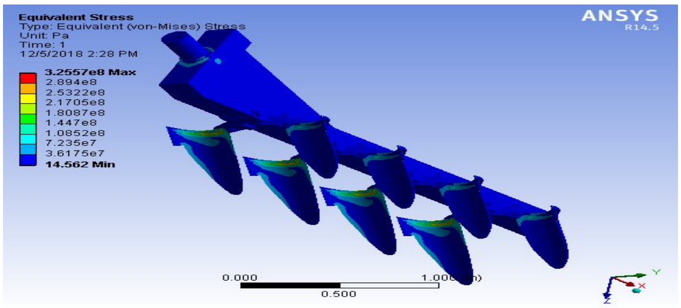


Fig: Stress

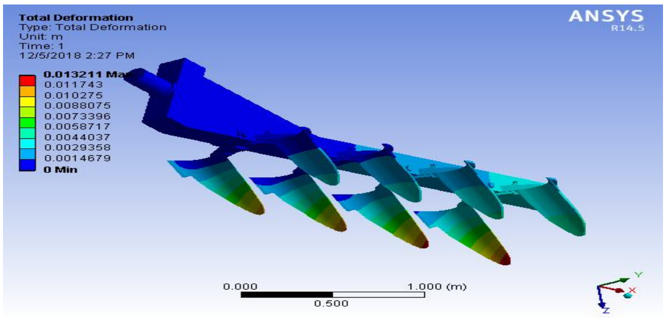


Fig: Total Deformation

Model Analysis:

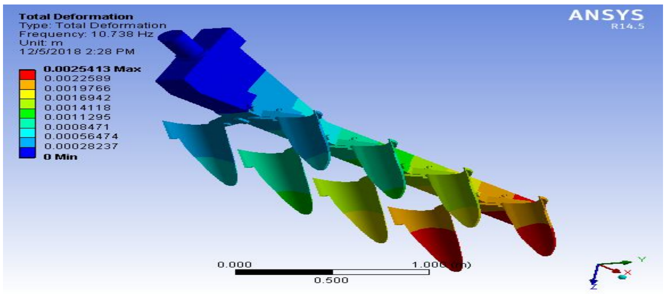


Fig: Mode 1

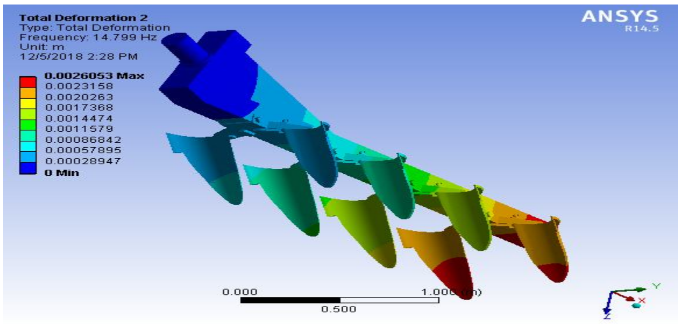


Fig: Mode 2

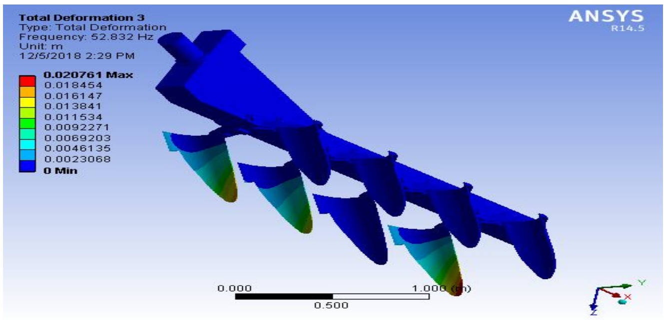


Fig: Mode 3

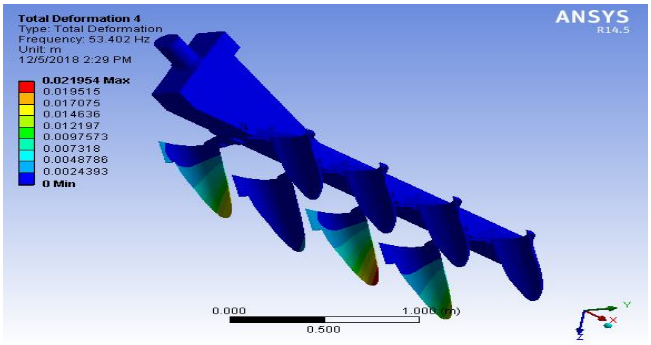


Fig: Mode 4

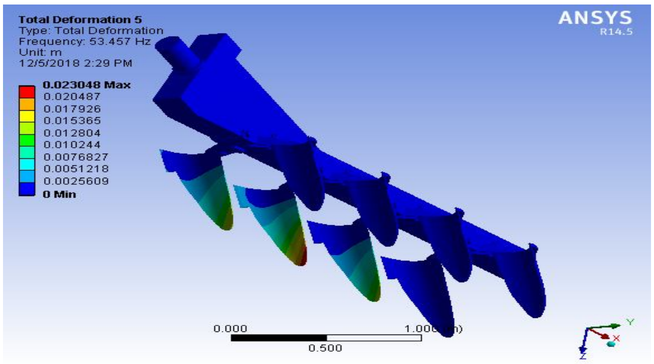


Fig: Mode 5

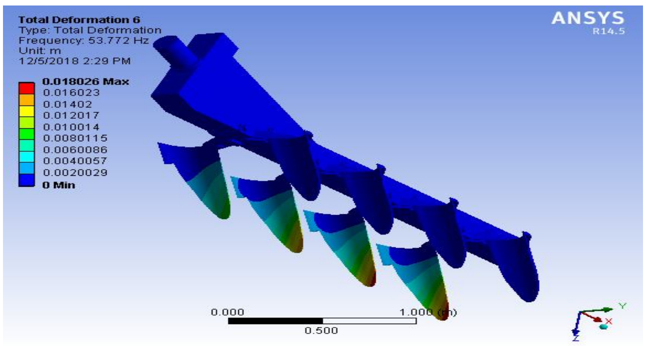


Fig: Mode 6

Results:

Material	Total Deformation (m)	Equivalent stress (Mpa)
Gray cast iron	0.024066	326.15
Stainless steel	0.013211	325.57

Table: Total Deformation and Equivalent stress

Martial/Modes	Stain less steel		Gray Cast iron	
	Frequency(Hz)	Total Deformation(mm)	Frequency (HZ)	Total Deformation(mm)
Mode 1	10.738	2.54	8.3153	2.65
Mode 2	14.799	2.60	11.444	2.71
Mode 3	52.832	20.761	40.892	21.614
Mode 4	53.402	21.954	41.333	22.80
Mode 5	53.457	23.048	41.374	24.05
Mode 6	53.772	2.0029	41.619	18.88

Table : Model Analysis results

V. CONCLUSION

In this project, I want to conclude that the reversible plough with 8 wings is efficient. By observing the analytical details of reversible plough with the grey cast iron and structural steel materials at different modes, deformation is 0.024m, 0.0132m and the stress is 326.15Mpa, 325.57 Mpa respectively. So structural steel material is preferable for reversible plough than the grey cast iron.

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