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RESEARCH PAPER

Structural analysis of remote control precision planter using CAD software

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Abstract : Proper design of agriculture implements is necessary to increase their working life and reduce the farming costs. In this study Creo Parametric software was used to carry out finite element analysis of two components of remotecontrol precision planter. 3D model of remote control precisionplanter was made using Creo 4.O software and static structural analysis were carried out using Creo 4.O simulation software. Dimension of components of remote control precision planter was selected using some crop parameters, DC motor capacity, soil type etc. Results of the simulation showed that maximum deformation was observed as 0.00009 mm for planter tine and maximum deformation for the frame was observed as 0.025 mm at the given boundary conditions while maximum equivalent stress (von-mises) stress was analysed as 42.87 MPa for Frame and 10.24 MPa for planting tine. The maximum shear stress was found as 17.10 MPa for the structural frame and 5.34 MPa for the planting tine of remote control precision planter. Maximum and minimum principal stress for frame was observed as 26.04 MPa and -7.54 MPa, respectively.

Key Words : Simulation, Planter, FEA, CREO, CAD

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INTRODUCTION

In the agricultural machinery industry, especially in small and middle scales, insufficient technical knowledge, usage of new technology and incautious design features can cause problems such as breakdowns, failures etc., during the manufacturing or field operations. Failure of machinery devices is one of the major problems in engineering (Javad *et al.,* 2011).

Technologies and computer capacity currently available allows to employ design software and numerical methods to solve complicated problems in very wide disciplines of engineering especially in field of agriculture (Vegad and Yadav, 2018).The goal of modern farming system is to economize energy consumption and to reduce farming cost. Optimal design of agricultural machines proportionate to the present tractor power must be considered in order to achieve this goal (Vegad *et al.,* 2016).

In 2010, conducted deep tillage optimization by means of finite element method; case study for a subsoiler tine. The study focused on obtaining optimum geometry parameters of a subsoiler tine by using computer aided engineering (CAE). A field experiment was conducted

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to determine draft force of the subsoiler. The results from the experimental study were used in the finite element analysis (FEA) to simulate stress distributions on the subsoiler tine. The maximum equivalent stress of 432.49 MPa was obtained in the FEA. Visual investigations and FEA results showed that according to the tine's material yield stress point of 355 MPa, plastic deformation was evident. Based on the FEA results, an optimization study was undertaken to obtain optimum geometry parameters without the occurrence of plastic deformation. According to the optimization study, optimum parameters of the tine geometry and maximum equivalent stress of 346.61 MPa were obtained. In addition to this, the total mass of the tine was reduced by about 0.367 kg (Topakci *et al.*, 2010).

The process of soil cutting was modeled using Finite Element Method (FEM) considering the effect of forward speed, rotary speed and soil moisture content on rate of stress applied to the soil. It was concluded that increasing forward speed led to decrease in the applied stress and increasing the rotary speed and soil moisture content led to increasing the applied stress on soil. The rate of stress in different conditions was compared with the allowed stress in soil and also the additional stress that led to aggregate powdering (stress required to break soil clods and convert soil in to powder foam) was computed (Alavi and Hojati, 2012).

Design of machine is not an easy task. Over a period of time, design of different machines was done by using the paper and drafting tools, but now most of the designing work is done by using CAD (Computer Aided Design) tools. CAD technology is very helpful for the design engineers as it provides extendibility that makes design easy. CAD software can help in future expansion of model by providing facilities to modify the designed work later (Shinde and Kajale, 2011). Many agricultural engineers and scientist moving toward alternate option of fossil fuel, also working on automatic and automation equipment. Due to lacking of labour, insufficient time, lack of precision in planting to harvesting process all these are main reasons for introducing robotics technologies into agricultural sector. For adopting robotics as comparing to other sectors because of we are combine two (Mechanical + Electronics) really challenging. We have to take care sensitive sensors do not affect machinery design.

Farm mechanization has long been known to provide a number of economic and social advantages to farmers. The most important of the economic benefits is the enhanced yield that comes as a result of increased mechanisation.Therefore, it is very important for the designers and agricultural machinery manufacturers to predict deformation and structural stress distributions on the machine elements during operations, which will allow them to manufacture optimised machinery by using predicted knowledge. Therefore, proper design of any machinery are necessary in order to increase their working life time and reduce the farming costs. So, the objective of this study was the analysis of important components of Remote control Agricultural vehicle using computer aided design (CAD) applications.

MATERIAL AND METHODS

Finite element analysis of the remote control agricultural vehicle frame:

To achieve the objectives of the present study, dimensions of remote control agricultural vehicle frame was taken as per power source, DC motor capacity, crop practices etc. Selection of square pipe as per standard (Indian Standard, 1997). The three important steps in CREO programming used for CAD modelling and analysis are Pre-processing, Solution and Post processing Kamboj *et al.*, 2012). The same steps were followed in the current research work.

Model design:

A solid model of remote control agricultural vehicle was created using Creo software. In this study we divided whole design model into two part, 1st part was frame structure at which whole components mounted and 2nd part was furrow opener which working in soil. The 3D solid model of both component are given in Table A.

Table A : Material properties

	Furrow opener	Frame
Material name	Hot rolled structural steel	Galvanised steel
Elastic modulus (MPa)	205000	200000
Poisson ratio	0.29	0.29
Density (g/cc)	7.87	7.80
Tensile strength ultimate (MPa)	420	510
Yield strength (MPa)	350	470
Hardness (BHN)	135	70

Mesh generation:

After assign material, model was meshed by threedimensional elements, SOLID 45. Fig. A. shows the created model in the meshing condition. The size of finite models was approximately 4593 elements, 720 nodes for furrow opener, 15716 elements, and 5262 nodes for frame.

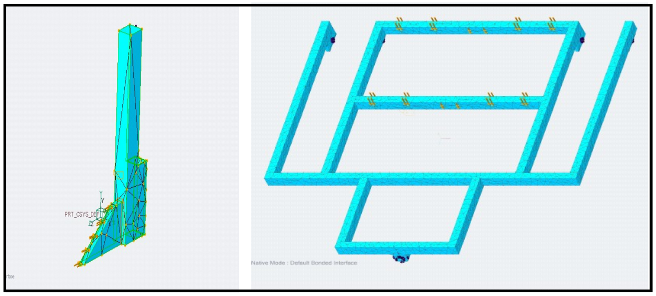

Fig. A : Mesh structure of planting tine and frame structure of remote control precision planter

Boundary and loading conditions:

The boundary conditions are the critical factors for the correctness of calculation.In this study frame was fixed by pin joint constraint at 3 different location and furrow opener tine was fixed top portion of shank through fixed joint constraint. All of these conditions were constrained in the all degree of freedom. This makes the shanks to not able to move or rotate in any direction (Jakasania *et al.,* 2016).

Maximum draft force, which was obtained from the experimental study, applied on surface of narrow share of furrow opener tine as 200 N on solid model of furrow opener tine.

For frame two different load applied on rear portion of frame. These load set were theoretical predicted weight of battery unit and planting assembly unit, which was total 600 N. Battery unit and planting assembly will be fitted on frame using fastened. Boundary condition were applied on solid model of both (furrow opener tine and frame) as shown in Fig. B.

The simulation was carried out after defining boundary conditions. The parameters selected for static analysis of remote control agricultural vehicle was total deformation, equivalent stress, principal stress, shear stress.

RESULTS AND DISCUSSION

A solid geometry of Parts of remote control agricultural vehiclewas developed in CREO PARAMETRIC software and exported to CREO PARAMETRIC SIMULATION package. The next important steps are meshing and applying loading and boundary conditions in the pre-processor so that simulation can be run to get a solution and generate results in the post-processor. The minimum and maximum developed stress in the fastened area of remote control agricultural vehiclewas indicated in the colour chart from blue to red, respectively. The colour indicated from blue to red is the minimum and maximum value for all the deflection and stresses on the remote control agricultural vehicle, respectively.

Volume and mass of the remote control agricultural precision planterwas discovered as 1230114 mm^3 and 9.60 kg, respectively for Frame. Volume and mass of the remote control agricultural precision planter was discovered as 125045 mm^3 and 0.99 kg, respectively for planter tine. Hot rolled structural steel having yield stress of 350 MPa was selected as a material of the planter tine and galvanized steel having yield stress of 470 MPa was selected as a material for planter frame.During simulation, the maximum deformation was observed as 0.00009 mm for planter tine and maximum deformation for frame was observed as 0.025 mm at the given boundary conditions which appeared at the end of the share which is shown in Fig. 1.

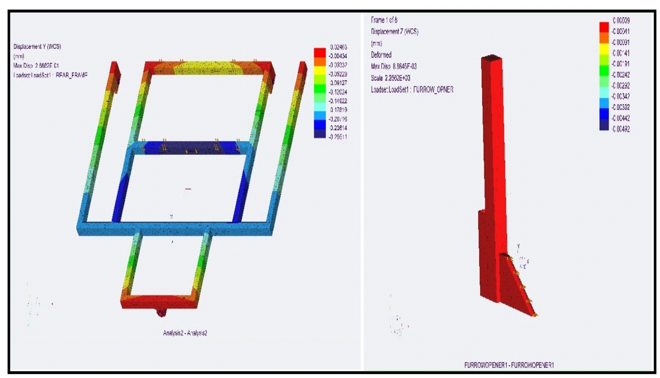

Fig. 1 : Maximum deformation planter tine and frame

The maximum equivalent stress was analysed as 42.87 MPa for Frame and 10.24 MPa for planting tine as shown in Fig. 2 whereas maximum and minimum principal stress for framewas observed as 26.04 MPa and -7.54 MPa, respectively (Fig. 3). In designing of frame structure and planting tine, it is desirable to keep the stress lower than the maximum or ultimate stress at which failure of the material takes place.The maximum shear stress was found as 17.10 MPa for structural frame and 5.34 MPa for planting tine of remote control precision planter. (Fig. 4).

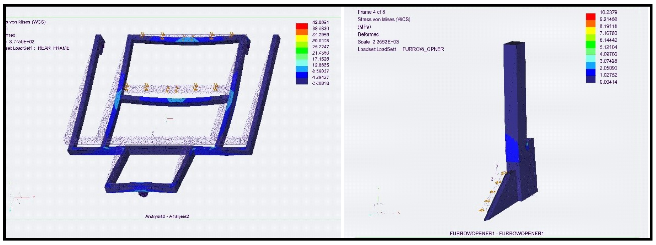

Fig. 2 : Equivalent (Von-Mises) stress of frame and planting tine for remote control planting unit

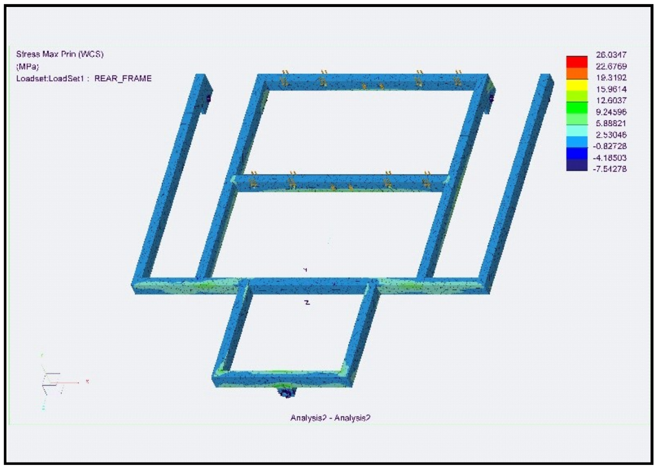

Fig. 3 : Maximum principal stress for frame structure for remote control precision planter

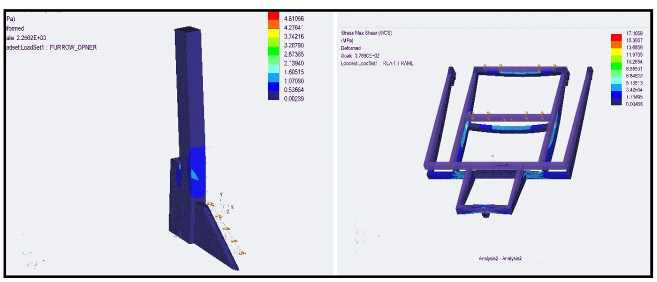

Fig. 4 : Maximum shear stress of planting tine and frame of remote control planter

Conclusion:

For the development of any important product, Computer Aided Design (CAD) is an effective tool. The design of two main parts of a remote control precision planter were investigated using the CAD approach in this study: one was the structural frame on which all electronics components were attached, and the other was the planting tine. At the given boundary conditions, maximum deformation for planter tine was 0.00009 mm and maximum deformation for frame was 0.025 mm, while maximum equivalent stress (von-mises) stress was 42.87 MPa for Frame and 10.24 MPa for planting tine, according to simulation results. The maximum shear stress for the structural frame was found to be 17.10 MPa, while the planting tine of the remote control was found to be 5.34 MPa.Maximum and minimum principal stress for frame was observed as 26.04 MPa and -7.54 MPa, respectively. In this study, maximum shear stress was lower than the yield stress of material so theses design parameter with individual material selected for further fabrication work.

REFERENCES

Alavi, N. and Hojati, R. (2012). Modeling the soil cutting process in rotary tillers using finite element method. *J. Agric. Technol.*, **8**(1): 27-37.

Indian Standard. (1997). *Hollow steel sections for structural use - specification*, IS: 6690-1981.

Jakasania, R.G., Vadher, A.L. and Yadav, R. (2016). Structural analysis of parabolic type subsoiler using cad software. *Internat. J. Sci., Environ. & Technol.*, **5**(5): 3415-3422.

Javad, T., Seyed, S. M. and Reza, A. (2011). Static and dynamic analysis of front axle housing of tractor using finite element methods. *Australian J. Agric. Engg.*, **2** (2) : 45-49.

Kamboj, P., Singh, A., Kumar, M. and Din, S. (2012). Design and development of small scale pea depoding machine by using CAD software. *Agric. Engg. Internat.: CIGR J.*, **14** (2): 40-48.

Shinde, G.U. and Kajale, R.S. (2011). Design optimization in rotary tillage tool system components by computer aided engineering analysis. *Internat. J. Environ. Sci. & Development,* **3** (3) : 279-282.

Topakci, M., Celik, H. K.,Canakci, M., Rennie, E.W., Akinci, I., and Karayel, D. (2010). Deep tillage tool optimization by means of finite element method: Case study for a subsoiler tine. *J. Food, Agriculture & Environment*, **8** (2): 531-536.

Vegad, G. M., Yadav, R. and Jakasania, R. G. (2016). Structural Analysis of Hatchet Type Rotavator Blade in CAD Software. *National Conference on Recent trends in Engineering, Management, Pharmacy, Architecture and Science.*

Vegad, G.M. and Yadav, R. (2018). Design analysis and optimization of rotary tiller blades using computer software. *AMA AgricMech Asia Afr Latin Am*, **49** (1) : 43-49.