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Model Analysis of Seed Drill Ground Opener (TYNE)

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Abstract: ***In agricultural, sowing and seeding are important processes in the crop development. To increase profit & yield of crop, it is necessary to reduced human effort & time required for seeding process. In this process it is necessary to develop agro equipment. Present study is focused on design of seeding tool (tyne) to reduce effort and time of seeding. The model is subjected to standard soil resistance & stress & deformation distribution is studied at different cross section byFEA.***

Keywords: Tyne, Ansys, FEA

1. Introduction

A seed drill is a seeding device which precisely positions seeds in the soil and then covers them. The seed drill sows the seeds at equal distances and proper depth. This makes sure that the seeds also get covered with soil. Before the introduction of the seed drill, to plant seeds by hand was the common practice. Planting was very indefinite and wasteful which led to a poor distribution of seeds, leading to low productivity. Furrow Opener as shown in figure 1 is the key element of a seed drill. It is also called as Seed cum fertilizer drill. They deliver both the seeds and fertilizers simultaneously in an acceptable pattern. Seed cum fertilizer drill has a large seed box which is divided lengthwise into two compartments, one for seed and another for fertilizers distribution. Functions of tyne are to carry the seeds and fertilizer in separate compartments, to open furrows at uniform depths, to meter the seeds and fertilizers, to deposit the seed and fertilizer in the furrows in an acceptable pattern, to cover the seed and fertilizer and compact the soil around the seed. Furrow openers consist of tyne as shown in figure 2, a shovel, boot and tubes for seed and fertilizer. It is found that due to deformation of tyne, uneven amplitude occurs which led to uneven depth of seeds causes to less fertilization of seedling. Vibration analysis plays a very major roll in design engineering. By this analysis we can decide, various parameter of seed drill which are the key elements of this machine. This study will give the idea about to increase the tool life.

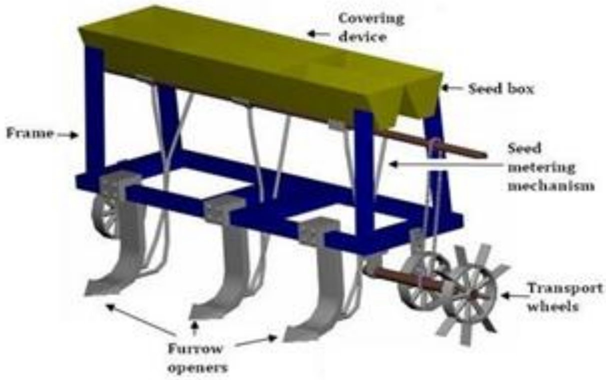

Figure 1: Seed cum Fertilizer Drill

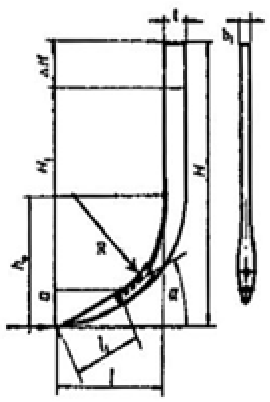

Figure 2: Tyne

2. Model Analysis

Seed cum fertilizer drill is the essential machine which farmers must be used for uniformly of seeding and better emergence of seedling. Many successful design of this machine have been released by researchers.

Seed and Fertilizer drill consist following major parts:

Frame,
Seed and fertilizer box,

Furrow openers,
Seed metering mechanism,
Power transmission wheel

3. Design Optimization Procedure

Design optimization is the process of finding the conditions that gives the maximum or minimum value of the function". Optimization is the act of obtaining the best result under given circumstances. Primary aim of optimization determine the most suitable combination variables, so as to achieve minimum deflection of the tyne subjected to functional &behavioral and geometric constraints imposed with the goal of optimality being by the objective function for specified loading or environmental condition.

Three features of optimization problem are:

1. The design variable.
2. The constraint.
3. The objective function.

In many practical problems, the design variables cannot be chosen arbitrarily, they have no satisfy certain specified functional and other requirements. The restrictions that must be satisfied in order to produce an acceptable design are collectively called design constraints.

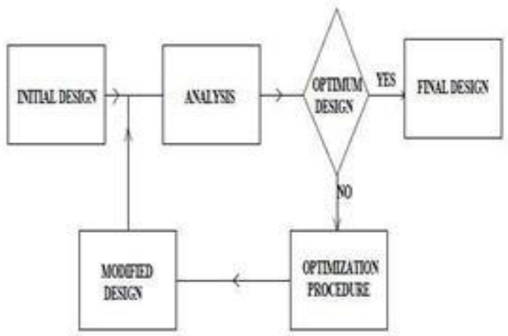

Figure 3: Process of optimization

4. Various Parameters and Conditions

Following parameter is considered in designing of model.

1. a_{max}= Maximum depth of tyneis in the range of 85 mm to 90 mm l_1= Inclined length of opener ranges from 100 to 200 mm
2. α = Load angle rangs from 45-50º
3. R = Radius of curvature must be less than or equal to130 mm
4. h_0= Height from centre of radius must be less than or equal to 180 mm
5. H_l = Maximum clearance between the land surface and the lower edge of the tyne should be 200 mm
6. F_0= Soil resistance is assumed to be 3 to 5 times higher than actual average soil resistance (Fx)
7. t = Thickness of tyne ranges 130 mm to 140 mm.
8. The most assumed ratio of thickness to width of tyne is taken as 1:3 to 1: 4

5. Design Variables and Constraints

For the design to be safe, following constraints should be within the given parameters.

A. Design Variables

To achieve the proper depth for sowing, we have to consider the following parameters

1. Design of tyne
2. Load angle
3. Working Depth
4. Working Share

B. Constraint Equations

The restrictions that must be satisfied to produce an acceptable design are called design constraints. For a safe design all the constraint should be within permissible limit.

1) Constrain for load angle

$\alpha = \sin^{-1}(a_{max}/ l_1)$ Where,
a_{max}= Maximum depth of tyne l_1= Inclined length of opener

2) Constraint for radius of curvature

$R = (h_0 - l_1 \sin\alpha)/ \cos\alpha$
Where,
R = Radius of curvature
h_0= Height from centre of radius l_1= Inclined length of opener
α = Load angle

3) Constraint for height

$H = a_{max} + H_l + \Delta H$
Where,
H = Total height of tyne a_{max}=Maximum depth of tyne
H_l = Maximum clearance between the land surface and the lower edge of the tyne
ΔH = Length of fitting of tine to frame.

4) Constraint for width of tyne
$b = 4t$
Where,
b= Width of tyne
t = Thickness of tyne

5) Constraint for soil resistance
$F_0 = 4 F_X$
Where,
F_0= Soil resistance
F_X= actual average soil resistance

6) Constraint for bending stress
$\sigma = 6 F_0(H_1 + a_{max}) / b_1 t^2$
Where,
σ =Bending Stress causing the tyne to bend

F_0= soil resistance
H_l= Maximum clearance between the land surface and the lower edge of the tyne
a_{max}=Maximum depth of tyne b_1= Width of tyne
t = Thickness of tyne

7) Constraint for torsional stress

$\tau = 9\ F_0 W_w / 8\ tb_1^2$
Where,
τ =Torsional stress acting on tyne when turning the opener inside the soil
F_0= soil resistance
W_w= Water content in soil b_1= Width of tyne
t = Thickness of tyne

8) Constraint for reduced stress

$\sigma_{zs} = (\sigma^2 + 4\tau^2)^{1/2}$
Where,
σ_{zs}=Reduced stress
σ = Bending Stress causing the tyne to bend
τ =Torsional stress acting on tyne when turning the opener inside the soil

9) Constraint for maximum deflection

$\delta_{max} = Fl^3 / 3EI$ Where,
δ_{max}=Maximum deflection
F= Force
l =Total Length
E= Young's modulus of elasticity
I = Moment of inertia

6. Illustrative Examples

The 3D model is developed in solid works and imported into ansys.

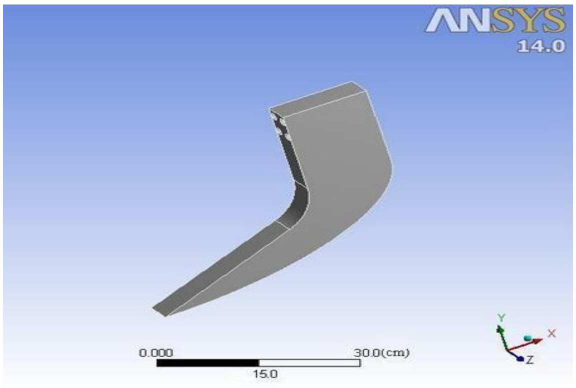

Figure 4: 3D model of tyne

For fixed condition and start from starting point 0 Hz frequency and end with point 232.2 Hz frequency the results are shown in figure 4 to 9. For different frequencies mention below by keeping load generated due to very heavy soil resistance is 16.875 KN.

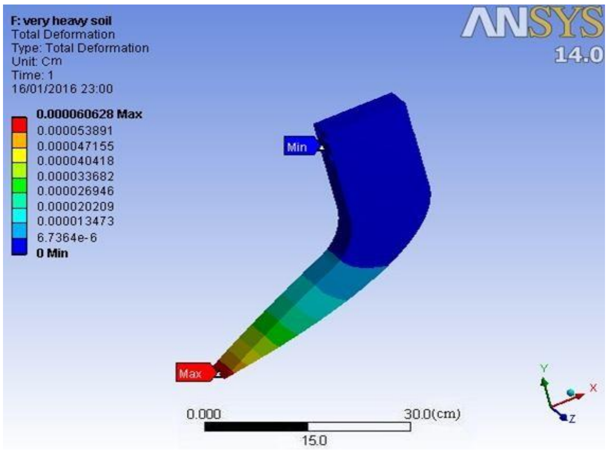

Figure 5: Total deformation at 0 Hz frequency

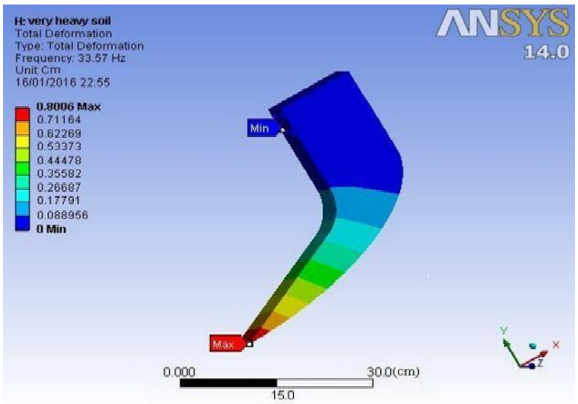

Figure 6: Total deformation at 33.57 Hz frequency

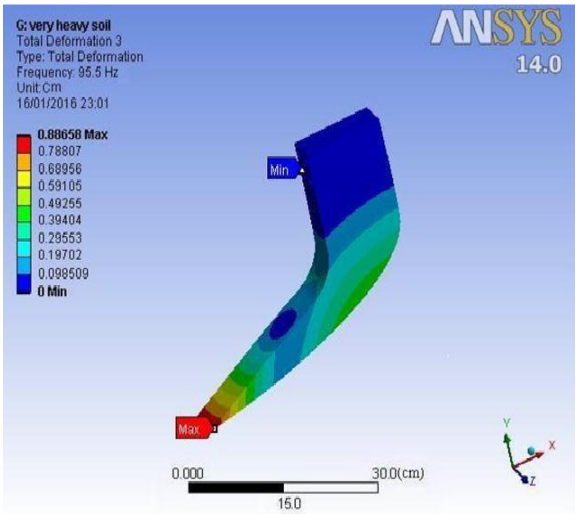

Figure 7: Total deformation at 95.5 Hz frequency

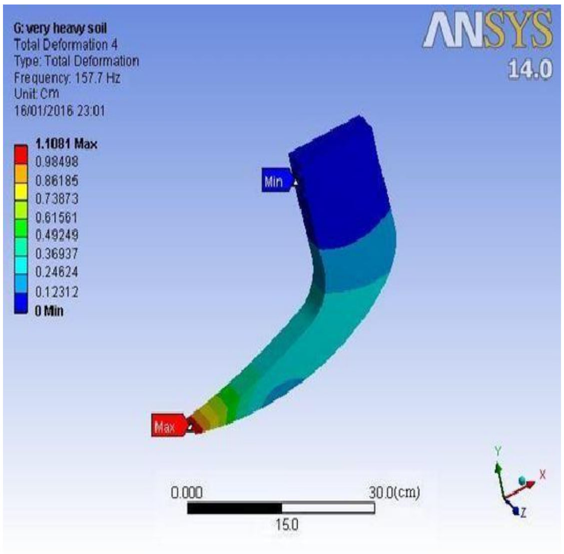

Figure 8: Total deformation at 157.7 Hz frequency

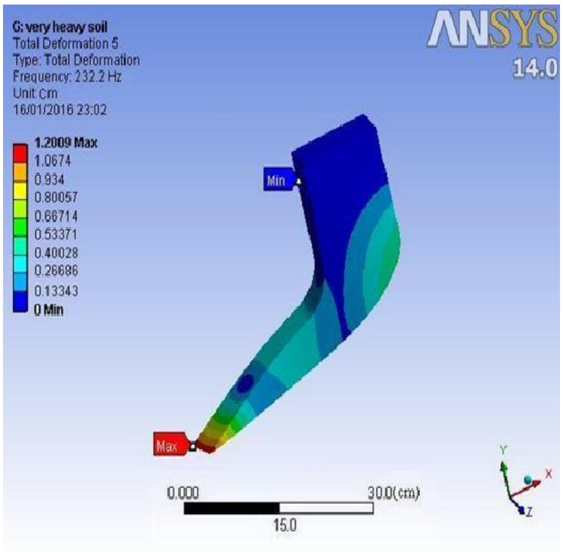

Figure 9: Total deformation at 232.2 Hz frequency

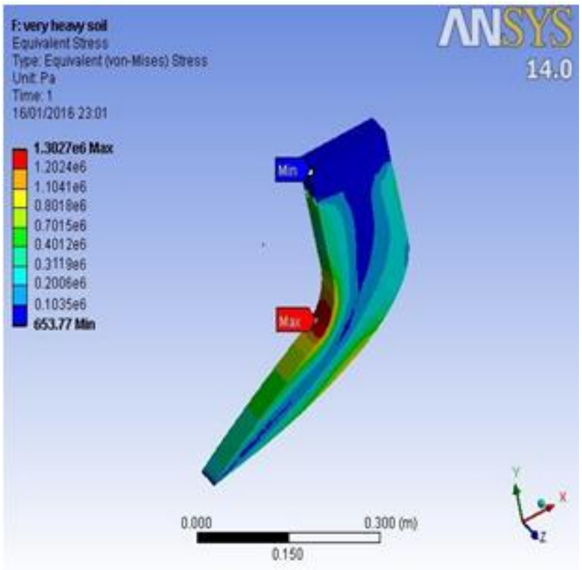

Figure 10: Equivalent Stress at given load condition

The total deformation result shown in graphical form as below:

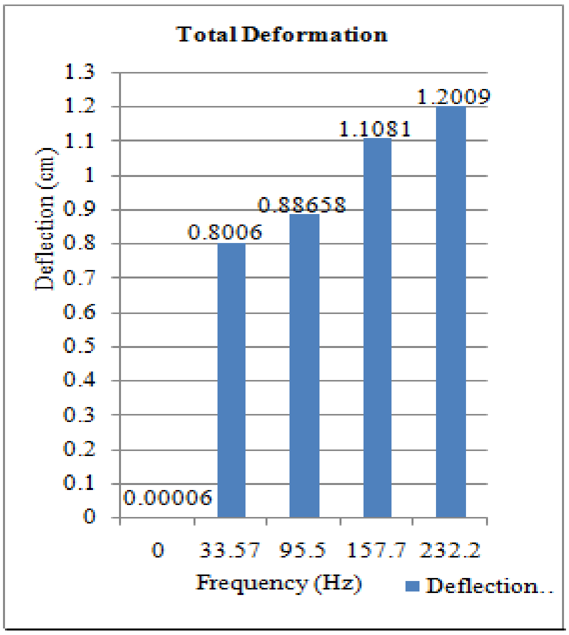

Figure 11: Deflection v/s Frequency

7. Conclusions

The control parameters measure in term of frequency of the seeding tool. In our project depth controlling parameter create deflection on the tyne.

Maximum deflection at tip and minimum deflection at top of the tyne. Maximum stress at the center and minimum stress at top of tyne.

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