

Design and Development of Mulching Paper Laying Machine

Harshvardhan K. More¹ Dr. Subm Khan² Dr. S. S. Pardeshi³

Abstract— Mulching paper laying machine was developed to mechanize the conventional mulch paper laying .mulching paper roll is mounted on equipment main fame and soil covering assembly are mounted on frame structure as shown. Pulling arrangement for this machine is suitable for bull lock cart and also for tractor. Forces to be calculated for pulling as per soil density 2200 kg/m³. This machine is to be developed as per cheap manufacturing cost and also to be portable for handling purpose and disassembling . Various parameter like soil temperature and Soil density is to consider from catalog.
Key words: Plastic Mulching Paper Roller Unit, Soil Covering Assembly, Press Roller Wheel Assembly

I. INTRODUCTION

MULCHING is process of covering soil by plastic or organic mulches to make favorable condition for plant growth for efficient crop production. Natural mulches such as leaf, straw, dead leaves and compost have been used for centuries. Past 60 years the advent of synthetic materials has altered the benefits of mulching. These new materials have combined features exhibiting strength, flexibility, light-weight, easy and low cost production. Plasticulture (polymer usage in horticulture) is mainly concentrating plastics on horticultural crop plants and their associated yields rather than the science behind machinery-designed specifically for the planting and harvesting processes. Plastic mulches are helps to prevent the establishment of weeds in many vegetable crops. There are several types of mulching sheets available in market as per color (black, transparent, 2 sides color) ,biodegradable polymer and also available in different width sizes varying from (900mm to 1200mm) with different gauge thickness. Plastic mulching by conventional method requires more human labor, more time and more cost of operation. Keeping the above facts this machine is design for manual pulling and tractor pulling arrangements. Thus mulching paper laying machines are manufacture is heavy and costlier. As per the frequency of use and loading condition this purposed model is design. This design model having main purpose of cost effectiveness for manufacturing as well as weight optimization for minimum effort required.

II. LITERATURE REVIEW

Krish S. Iyenger al. [1] practical manual on plastic mulching gives the information related mulching papers and their varieties which are categories for different crop harvesting.

V. P. Veer al. [5] has done design of mulching paper laying machine with drip laying and hole punching on mulching paper. Which result in 3 operations in one machine can be able to done. Linear low density polyethylene mulch paper are to be consider for designing

Prof. Amey Tipayle al. [6] design advance mulching paper laying machine as per reducing capital cost as well as laying time also placing the drip irrigation pipe in one pass of machine.

H.D. Jadhav al.[7] design for automatic mulch laying and hole generation in farm. This machine has provision of tractor mounting and shock absorbers along the

wheel wich reduce the frame vibration. Square hollow section are to be use for frame model as light weight section properties.

L.E.Bailey al. [8] Machines for Laying Mulches are developed in 1922 for mulch paper roller which is robust in design with big roller. The machine design are having heavy bulky structure.

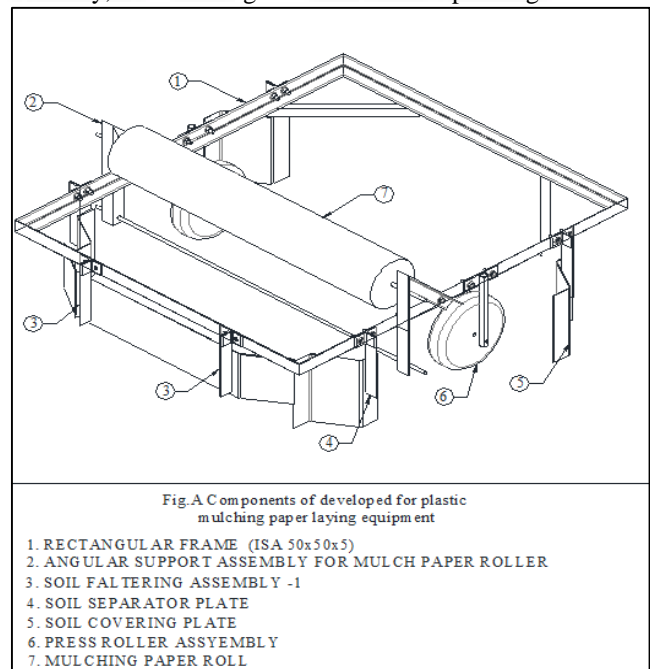
S. Marihonnapanavara al. [9] design for tractor operated machine. In this research we observed power calculation is to be done for pulling effort from tractor. This machine is design for mulching and drip lying.

III. METHODOLOGY

This equipment consist of plastic mulch rolling assembly, soil spreading and soil covering assembly, press-wheel assembly. Plastic roller carrier of length of 1.3m biased on the width of plastic mulching. For designing of machine frame loads to be considered as per 250 micron gauge which coverage arte of 4.29m²/kg having per meter weight of 0.233kg/m.

Plastic mulches to be selected in 3 different width's 900mm, 1000mm, 1200mm.

Plastic mulch is place under the press- wheel before going to start the mulching paper laying operation. Soil separating assembly and soil covering assembly are adjusted properly as per level of sari. Through the soil over the mulches at the edges of plastic make airtight covering for plastic mulch air tight mulching bed. Press wheel are to be made at the bottom of the trench and not on the upper side to stretch the plastic properly. The prototype model consist of mainframe, plastic mulch roller assembly, press wheel assembly, soil covering device and soil separating device.



IV. DEVELOPMENT PROCEDURE FOR MULCHING PAPER LAYING MACHINE

Mulching paper laying machine is developed by considering machine parameter and also optimization for cost of manufacturing. Parameter considered in development of mulching paper laying machine is discussed as per below.

A. Soil Loading Condition

Agricultural soil density is varying from 1600 Kg/m³ to 2200 Kg/m³. Soil surge angle to be considered of 25 deg. Which allow the load on front soil flatterer assembly of 11.24 N under maximum loading as well as soil separator and soil covering loading of 47.125 N are applied on the frame structure.

B. Main Frame

The frame of farm machine as light as possible to reduce cost as well as minimum requirement of propelling power but strong enough to resist the shock. The mainframe of structural steel made up of angular cross section with minimum 250 MPA yielding stress. Overall dimension of main frame is 1500mm along the length and 1300 along the width. Size of angular cross-section is 50x50x5 is to be considered.

C. Plastic Roller Unit

The plastic roll has to be slide onto the plastic roll carrier provided below the main frame of the equipment. The plastic paper has to be placed under the press wheel assembly before going to start the plastic mulch laying operation.

D. Soil Covering and Separating Assembly

Soil covering unit is working for lifting and throwing the soil over the mulch paper with MS profile sheet as well soil separating sheet is work for cutting and throwing soil outside before mulching paper placed.

E. Press Wheel Assembly

Press wheel are to be run at bottom level such that it will press mulching paper sheet properly to stretch over the soil for air tightness. Press wheel having inward angle to stretch the plastic mulch.

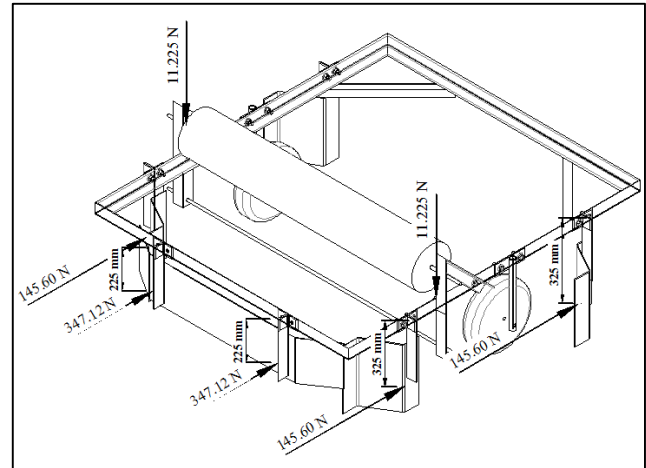
V. FRAME LOADING CALCULATION

Front flat loading on frame assembly:

F1 = 347.12 N at each arm location.

F2 = 145.60 N at each side arm location.

F3 = 22.43 N “ Considering mulching paper of 50 m roll with 4 Ft. wide (1220mm) having 0.0382 kg per meter weight”



A. Resultant Moment:

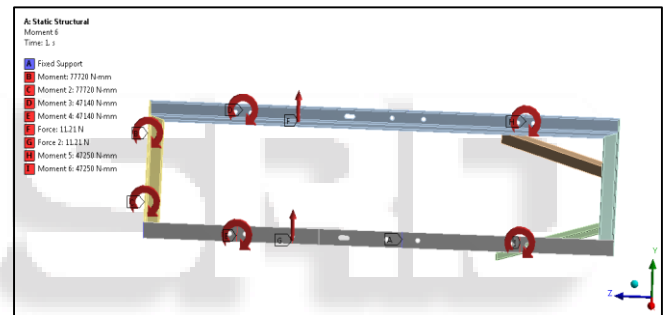
M1 = 77.720 N-m at each front side arm location.

M2 = 47.125 N-m at each side arm location.

VI. ANALYSIS OF FRAME MODEL

As per given loading condition moments are applied on the purposed frame structure.

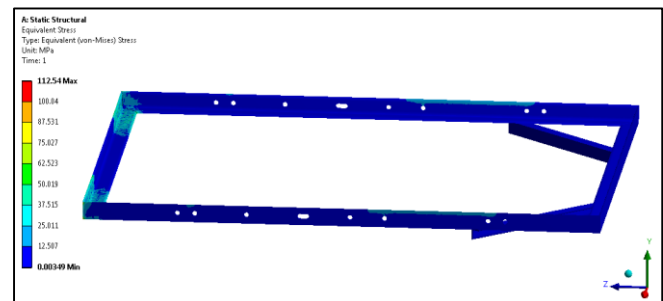
As shown below:



A. Frame is subjected loading as discussed below:

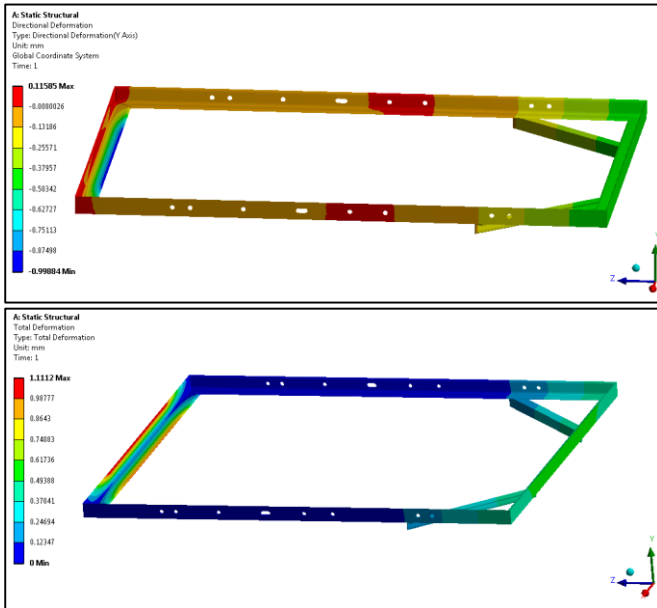
- 1) Torsion loading on front side of frame due to soil flatterer assembly = 77.72 N-m at 250 mm offset distance from main frame center.
- 2) Frame bending along near and far side with loading of 44.125 N-m at 325mm and 1225 mm from front side.

B. Resultant stresses developed on the main frame as below:



The stress developed along frame lie between 12.507Mpa to 25.011Mpa which is on safer side.

C. Resultant deflection on the main frame as below:



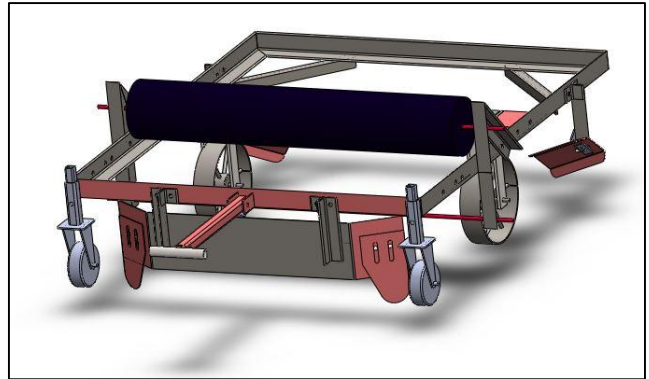
The above analysis report showing the deflection due to torsion loading of 1.1112 mm which is maximum on the frame.

VII. FABRICATED ASSEMBLY AND ISSUES WITH EXISTING ASSEMBLY



Fabricated wheel assembly as shown in above is having handle arrangement, wheel assembly and angular frame with soil flatter, spreader and accumulator welded assembly. The issues accrued with existing welded assembly is the wheel base of existing assembly is wider than paper lying on the soil profile. The another issue with the machine is to soil covering flat assembly is not working properly its stuck with soil and require high pulling fore to push in soil on their paper to reduce that issue we modified the machine design to overcome the issue.

VIII. NEW MODIFIED MODEL ASSEMBLY



For overcome the the issues in the existing assembly we have done several changes in the fabricated assembly.

Above fabricated assembly has made several changes as highlighted in different colors. To reduce pulling force of the existing fabricated assembly from soil spreader has been removed. The existing soil accumulator has been modified to new bolted assembly. Which shown in back side of the wheel.

Soil flatter has been modified at end with 2 vertical flats bolted by M12 bolts. To move on smooth surface the wheels are added on the front side of assembly which is useful in movement of the frame on road and also maintaining center of gravity in the 4 wheel spacing. The overall modification of the existing assembly is to reduce load on the frame and also usefully for soil covering.

IX. RESULT & DISCUSSION

As per the analysis values maximum stresses developed in the frame are below yielding condition (250MPa), which result that frame member is safer for given loading condition. Torsion loading of 77.72 N-m will result in 1.1 mm deflection in angular frame. Maximum stress developed in the frame would be of 30 MPa which concludes the factor of safety of 8. Thus more optimization will result in failure at hole location and also the loading is not suitable below M12 bolt.

Angular frame structure will reduce cost of manufacturing as well it is easily available. Angle welding is as per AWS standards to be considered. Higher factor of safety will give us frame rigidity.

The modified frame assembly is having less loading as comparable to existing frame assembly which results in frame load relaxation.

REFERENCES

- [1] K. S. Iyenger, "Practical manual on plastic mulching," National committee on plastic mulch application in Horticulture.
- [2] Weon tai jeon, bong su choi, samy a.m.abd el-azeem and yong sik ok (2011). "effect of green manure crops and mulching technology on reduction in herbicide and fertilizer use during rice cultivation in korea. African journal of biotechnology", vol. 10(1), pp. 1-8.
- [3] Espi, e., salmeron, a., fontecha, a., Garcia, y. and real, "Plastic films for agricultural applications", Journal of plastic film and sheeting 22:85-102.

- [4] Joel, F.R. (1995). "*Polymer science and technology: introduction to polymer science*". 3rd Edn. Prentice Hall, Upper Saddle River, p: 4-9.
- [5] V. P. Veer, P. R Thete , D. A. shinde , K. S. Vanve "*Mulching paper and drip laying machine*,"vol. 2, no. 2,, ISSN: 2456-0006. March 2017.
- [6] Prof .Amey Tipayle "*Advance mulching paper laying machine*", dept. of mechanical engineering, vol. 5, ISSN: 2321-0613. March 2017.
- [7] H. D. Jadhav , J.J. Kadam, A.D. Karche " *Automatic mulch laying and hole generation in farm*" vol. 7 ISSN: xxxx-xxxx.IJESC 2017.
- [8] L.E.Bailey, "*Machines for Laying Mulches* " US 1436139, country- US, 15August 1922.
- [9] Kepner, R.A., Roy, Bainer and Barger, E.L. (2005).Principles of farm machinery.CBS Publishers and Distributers (Pvt.) Ltd., New Delhi.
- [10]S. Marihonnapanavara "*Development and evaluation of tractor operated plastic mulch laying equipment*" Vol. 10, Rev. 2, Oct-2017 ,374-378 ,ISSN-0976-7223

