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Review paper on Simulation, Analysis and Design of Low cost Farm Machinery using Altair HyperWorks

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ABSTRACT

Majority of Indian farmers are very poor and marginal, cannot afford high cost power operated Farm machine. There is an urgent need to develop farming machinery, which are sustainable from environment and socioeconomic, points of view. Agriculture plays an vital role in Indian economy, provides livelihood support to about two-thirds of country's population directly. There are 1.2 million farmers having land ranging from 2-4 ha.Major crops grown in North Karnataka are redgram, sorghum, sun flower,maize,groundnut,sunflower. Most of the conventional tool and implements are being used by the farmers of this region for cultivation of crops which are time consuming ,less efficient and also cause human drudgery. Automation of Farm machinery system played a significant economic role by increasing agriculture production and reducing cost of cultivation by performing the farm operations speedily and efficiently. Thus it helps in increasing productivity and overall returns to the farmers. Although agricultural mechanization has improved productivity to great extent, still post-harvest value addition to the raw product in India is only 7% which is very less as compared to other countries.
Efforts were made still on to reduce the drudgery in intercultivating operation for poor famers by implementing a new virtual simulation design approach using CATIA software. Later the assembly file is imported in Hyperwork software to check its functional simulation and determined critical areas by applying flexible body dynamics concept. Low cost sustainable farm machinery systems are required to provide major contributions to farmer needs and enough food for the growing world population by using renewable energies. By reducing the drudgery and hectic work of farm operators, we can reduce the migration of rural labours to urban areas, greatly helping the national cause of arresting undesirable population movement.

Keywords: *Virtual Simulation Design, Hyperworks, Multibody Dynamics , FEA, Farm machine.*

1. INTRODUCTION

Traditional farming practices have evolved over the years for various processes [6].Historically; agricultural development played a central role as a driver of rural poverty reduction. However, recent trends show in slowing down of agricultural productivity growth and the marginalization of poor farmers [9]. The industrial revolution emerged to develop and manufacture better products in a faster and cheaper way. The beginning of mechanization of Indian agriculture was made by the use of improved hand tools and bullock-drawn implements [3].

The machinery and equipments used in the farm for raising crops are

1. Land development, Tillage, Seedbed Preparation

2. Sowing and Planting

3. Weeding, Intercultivating and Plant protection

4. Harvesting ,Threshing, Dehusking, and Deshelling

5. Post harvest and agro processing

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The basic principles, construction and working of farm machinery systems for different crops will enable to select appropriate machinery for simulation, analysis and design the same.

Energy is of critical importance for development and economic growth of a country. The latest assessment indicate that annual consumption of fuel consumption has exceed exploration of new reserves. However due to rapid raise in the prices of the fossil fuels and their limited availability, there is now a greater awareness for the development of renewable energy technology.Cost effective agriculture solutions will transform traditional farming into mechanized farming resulting in increased yield and productivity. This can be achieved by the development of relatively low-cost equipment with utilization of available solar energy, that can be utilized to perform a variety of functions.

The Virtual design simulation analysis and optimization of Intercultivator tool on the basis of finite element method and simulation method is done by using CAE-software CATIA, Altair's Hyperworks for the coplete analysis. The different Intercultivator tool parts are geometrically constructed as a solid model. The estimated forces acting on soil-tool interface are fed into software as a loading condition.

2. METHODS

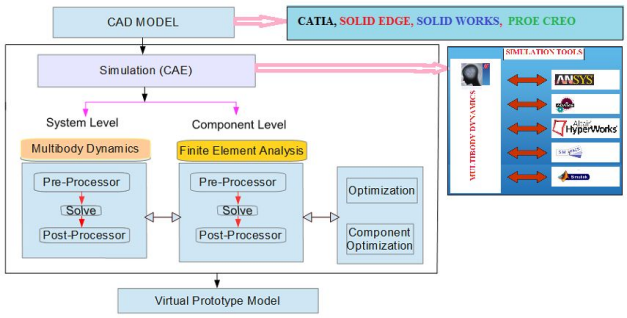

Figure 1: Simulation, Analysis & Design methodology

In general equipment/machinery fabrication industries, CAD technology has been very widely applied to various fields. But Farm machinery still remains an the primary stage, which based on hand work such as objects, models and drawings and samples to complete the whole process of Farm machinery body design method without using the modern CAD design software tools Rajashekar[9]. At present, foreign farm machinery companies have started to use CAD modern technology, while problems such as not precise enough, long design cycle still exist in domestic agricultural machinery companies.

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 tools. In comparison with traditional prototyping method, Virtual Simulation Design provides tremendous time and cost savings in making fully functioning physical model with the aid of CAD technologies.

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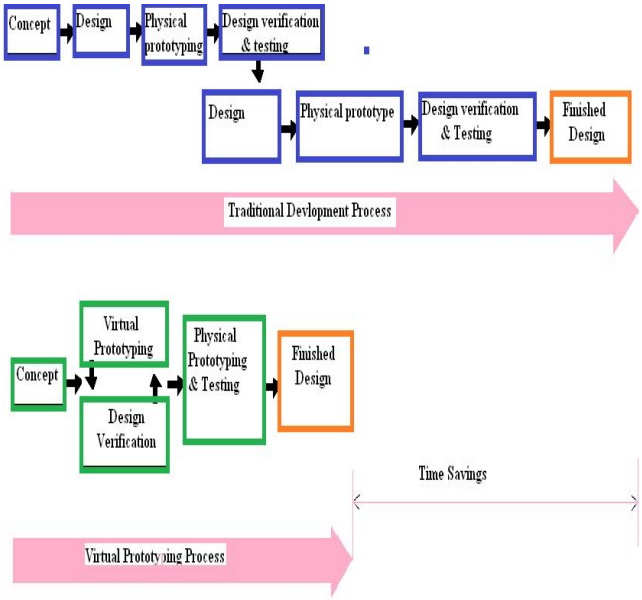

Figure 2.Traditional and Virtual Simulation Design

Finite Element Analysis is one of the methods used for evaluation of a structure under static and dynamic loads before making the main model which improve the design strength. Finite element method was used by many researchers in order to design the intercultivating tools or investigate the interaction between soil and tillage implement. An optimum design is one that is as effective as possible. Virtually any aspect of the design can be optimized: dimensions (such as thickness), shape (such as fillet radii), placement of supports, cost of fabrication, natural frequency, material property and so on. Any ANSYS item that can be expressed in terms of parameters is a candidate for design optimization. The ANSYS program can determine an optimum design that meets all specified requirements yet demands a minimum in terms of expanses such as weight, surface area, volume, stress, cost and other factors.

Sustainable farming emphasizes the conserving of his own resources. For a farm to be sustainable, it must produce adequate amounts of high quality foods, be environments safe and where appropriate, be profitable, sustainable farms minimizes their purchased inputs like energy fertilizers equipment and rely, as much as possible on the renewable resources of the farms itself.

In Practical application, it is discovered that the Base frame vibrated when the rotary Intercultivator removes weeds especially during the high speed cutting the vibration of the working bench is particularly significant. The main reason is that there exists imbalance inertia forces in the cutting mechanism, and the inertia forces effects on the base frame through the kinematic pairs and then to the ground. As the model imported from CATIA to ADAMS, all of the model components are defaulted as rigid body, while the base structure virtually is stiffness and damping. Therefore, in order to improve the accuracy in analysing the acceleration of the vibration, the working frame should be flexible treated before the vibration analyse. The flexible constraints was added by using of the dummy part in the AUTOFELX module in ADAMS [2],[3], then completed the flexible treatment of each angle iron, as shown in Figure 2.

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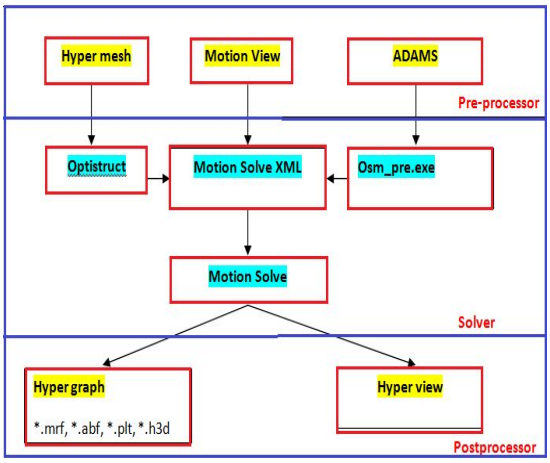

Figure 3. Virtual Simulation Design using Huperwork

Altair's Hyper Works module Motion Solve (pre and post-processor) and Motion Solve (Solver) is MBS software used to create virtual prototype for analyzing, optimizing, and simulating the mechanical system under "real" operating conditions. The process flow is shown in Figure The Motion Solve can take input from three different pre-process which is based on the extensible mark-up language (XML) format.

Hyper Mesh enables engineers to receive high quality meshes with maximum accuracy in the shortest time possible. A complete set of geometry editing tools helps to efficiently prepare CAD models for the meshing process. Meshing algorithms for shell and solid elements provide full level of control, or can be used in automatic mode. Altair's Batch Meshing technology meshes hundreds of files precisely in the background to match user-defined standards.

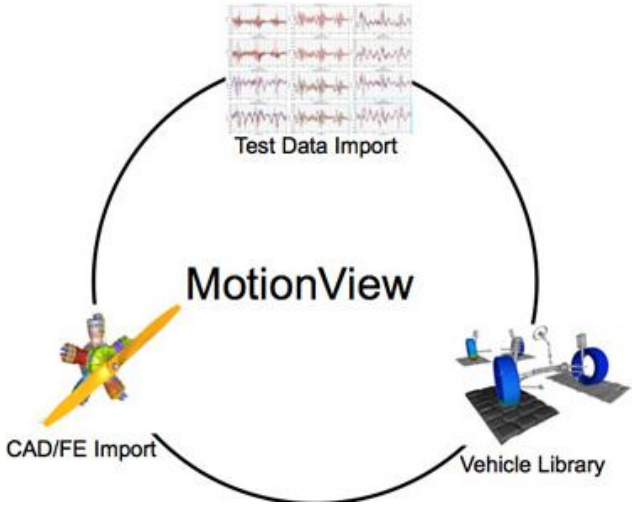

Figure 4. Overview of the modeling workflow

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Altair Hyper View is a complete post-processing and visualization environment for finite element analysis, multi-body system simulation, digital video, and engineering data. Hyper View combines advanced animation and XY plotting features with window synching to enhance results visualization. Hyper View also saves 3D animation results in Altair's compact H3D format, so users can visualize and share CAE results within a 3D web environment using Altair Hyper View Player. Amazingly fast 3D graphics and unparalleled functionality set a new standard for speed and integration of CAE results post-processing. Coupling these features with Hyper View's advanced process automation tools dramatically improves results visualization and reporting. Altair Hyper Graph is a powerful data analysis and plotting tool for all types of CAE data.

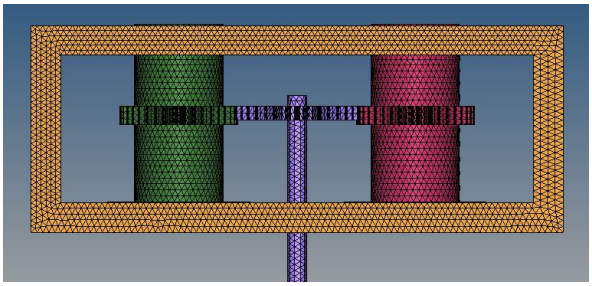

Figure. 5 Meshed Model of Desheller

Motion View is a pre- and post-processor for multi-body dynamics simulations which provide a user friendly environment for building MBD model and set up an analysis for Multi-Body Systems. Motion Solve is a system level, multi-body solver that is based on the principles of mechanics. It automatically formulates the equations of motion and numerically solves them. The results can then be plotted and animated to visualize the response of the system. Plotting is useful for examining detailed engineering calculations and animation is primarily used to visually evaluate the overall system behaviour.

Optimization

In general, optimization is to exploit the available limited resources to obtain maximum utility. The objective of optimal design is to achieve the best feasible design according to a required measure of performance and efficiency. Optimization is defined as a process of finding the conditions that give maximum or minimum value of a function and it is applied to solve many engineering structural problems.

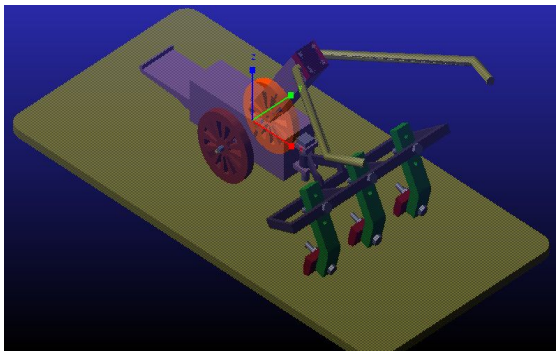

Figure. 5 Virtual Model of Intercultivator

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Fig. 6 Hyperwork Virtual Model of Farm Vehicle

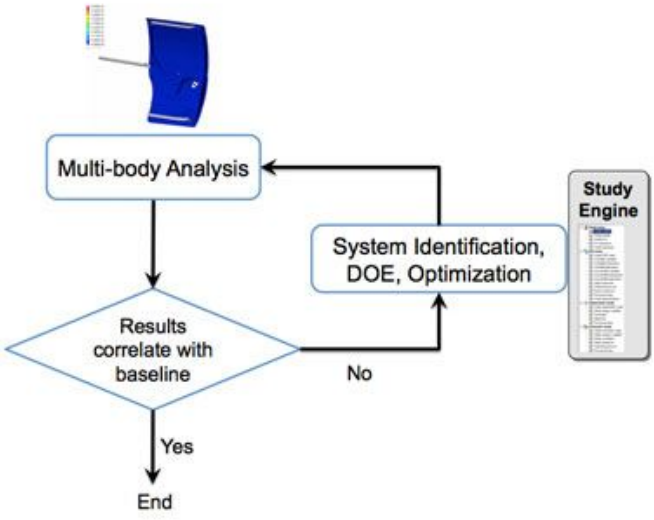

Fig. 7 Hyperwork MBD Flow diagram

The design process can be viewed as an optimization process to determine mechanical systems and structural parts that full fill ce rtain expectations towards their economy, functionality, and appearance using simulation based design process as shown in block diagram.

Altair HyperMesh is a high-performance finite element pre-processor to prepare even the largest models, starting from import of CAD geometry to exporting an analysis run

HyperMesh enables engineers to receive high quality meshes with maximum accuracy in the shortest time possible. A complete set of geometry editing tools helps to efficiently prepare CAD models for the meshing process. Meshing algorithms for shell and solid elements provide full level of control, or can be used in automatic mode. Altair's Batch Meshing technology meshes hundreds of files precisely in the background to match user-defined standards. HyperMesh offers the biggest variety of solid meshing capabilities in the market, including domain specific methods such as SPH, Noice Vibration Haarshness,Crash and CFD meshing.

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A long list of CAD formats ensures a high level of CAD interoperability. Altair's connector technology automatically assembles individual parts with their Finite Element representation. HyperMesh is entirely customizable. A extensive API library can be used to automate repeating tasks or do complicated math operations for model generation.

3. RESULTS AND DISCUSSIONS

Different intercultivating equipment were conceptually designed first using CATIA and analysed, optimized using ADAMS and ANSYS software. Sustainable Farm system has to be economically viable both in the short and long term perspective. Natural resources not only provide food, fibre, fuel and fodder but also perform ecosystem service such as detoxification of noxious chemicals within soils, purification of nutrient and control weeds, pest and diseases through biological and cultural methods.

Before the simulation, the average weeding resistance was measured by using of type micro-controlled electronic universal testing machine, and the result is 24.8N. In the dynamic simulation, added the cutting force to the 3D model of the cutting mechanism by using the STEP function of ADAMS, the cutting force F = STEP (TIME, 0.25, 0, 0.3, 24.8) +STEP (TIME, 0.45, 0, 0.5, -24.8).

A roto cultivator is designed in computer aided design software. The rotary motion and soil surface interaction is considered with respect to the soil Vs. tillage tool dynamics by considering the following factors effecting the tillage operation such as power (KW), maximum peripheral force (N),rotovator Tyne velocity (m/s),

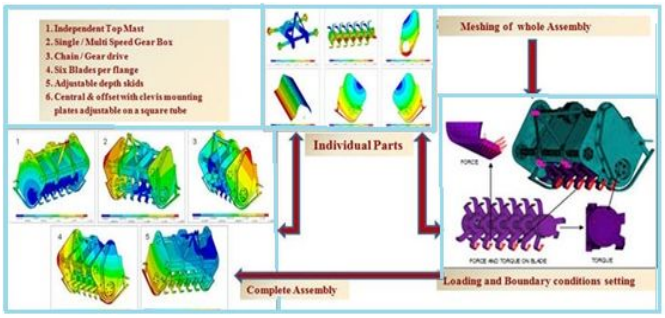

Figure. 8. Rotavator Analysis

Product features arise through complex interaction of subsystems. Modern simulation techniques can help in examining and designing machineries there by reducing the dependency on testing of physical models. The manual working machines rely on subjective evaluation of physical models by test operators to assess properties such as productivity, fuel efficiency and operability. This manual testing method is time-consuming, costlier and inaccurate. Variations in operator performance and environmental conditions lead to low repeatability of the tests which makes it difficult for a reliable assessment of the desired product robustness.

The design process can be viewed as an optimization process to find structures, mechanical systems, and structural parts that fulfil certain expectations towards their economy, functionality, and appearance. Generally, the design process is a highly iterative procedure and decision making process as shown in Figure 1.

The Finite element analysis and Multi-body dynamics analysis involves the simulation of rigid and flexi-body systems under the application of forces or motions and is used as a test bed for computational design testing. The results of computational analyses are used to determine design improvements.

Virtual simulation Design Analysis is generally adopted in product development in order to minimize the traditional reliance on testing of physical prototypes. It constitutes a major step towards solving the conflict of increase in cost

and duration to enhance the competitiveness in the market by exploring alternative system design and obtaining instant feedback.

4. CONCLUSION

The analysis of kinematic behaviour of the Farm machines considered are validated with Prototype are more economical and optimal. The present study focuses on the stress distribution on base frame and blade which are important for the designers and manufacturers in order to minimize the errors and breakdowns. The results of static structural analysis carried out for blades revealed that, the stress values developed in the blades were within the limits of the yield stress of the material. Hence, the blades designed and selected for the study could be adopted for the development of an Intercultivator.

Presently, a 3D solid model is the widely accepted product presentation, usually parametric. Second, for a virtual prototype to be presented as a real physical model, a human-product interaction model is desired. Ideally, a virtual product can be viewed, listened, smelled, and touched by an engineer or a customer. The machine designed here utilizes the solar energy in place of conventional fuel. In villages peoples are facing fuel shortage and also unavailability of required power supply. Deeper working depth and a slow travel speed can achieve good weed control. Therefore, it is very important to consider these two factors to achieve good weed control effect. By reducing the drudgery and hectic work of farm operators, we can reduce the migration of rural labours to urban areas, greatly helping the national cause of arresting undesirable population movement.
Energy availability is a major challenge worldwide. The price of crude oil is increasing as demand is too in geometric ratio. Hence usage of renewable energies can play a major role to achieve sustainable farm machinery systems.

5. ACKNOWLEDGMENT

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