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OPTIMIZATION OF COTTON SEED SEPARATION MACHINE

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ABSTRACT - *'Ginning, in its strictest sense, refers to the process of separating cotton fibers' from the seeds. The cotton gin has as its principal function the conversion of a field crop into a salable commodity. Thus, it is the bridge between cotton production and cotton manufacturing. Cotton Fibers must be separated from the seed before they can be spun to yarn and used to manufacture textile goods.*
Optimization is the act of obtaining the best result under given circumstances. In design, construction, and maintenance of any engineering system, engineers have to take many technological and managerial decisions at several stages. The ultimate goal of all such decisions is either to minimize the effort required or to maximize the desired benefit. Since the effort required or the benefit desired in any practical situation can be expressed as a function of certain decision variables.
Optimization of ginning machine for minimizing weight without affecting the structural strength is an important aspect of recent designs. In addition, designers have been trying to optimize the topology of machine members like the side plate platform area. This mass reduction can be optimized without compromising the structural integrity. This procedure is illustrated in this paper by using optimization code, Altair Optistruct for optimization of linear structures and using Hype mesh platform as the main finite element modeler.

Keywords - Ginning Maching; optimization; cotton seeds; weight, structural strength.

I. INTRODUCTION

Cotton crops have profound influence on India's economy. India ranks first in area (Ca 8.5 m ha) under cotton cultivation and third in cotton production (2.5 million tones) but has a very low productivity (Ca 300 kg lint/ha).During the 90's, India not only became self-sufficient with respect to its total cotton requirement under different staple grades, but also had some exportable surplus of cotton. The commercial quality of cotton fibers, as they develop in the balls, mainly depends on the pedigree of the strain and the agro climatic conditions under which the plant is grown. The inherent quality can be improved upon by cross breeding, selection and adoption of appropriate agronomic practices, but no improvement is possible after the cotton balls on the plant burst open. The important quality attributes being monitored by the cotton improvement scientists while evolving new strain are 2.5% span length, length uniformity ratio, micron ire, bundle strength, breaking elongation and maturity apart from ginning percentage (GP). The breeder has to ascertain the above fiber property for the hundreds of small samples of seed cotton every year as accurately as possible in a short time.
At one time the sole purpose of cotton gin was to separate fiber from seed. But today's modern cotton gin is required to do much more. To convert mechanically harvested cotton in to a saleable product, Gins of today have to dry and clean the seed cotton, separate the fiber from the seed, further clean the fiber and place the fiber in to an acceptable package for commerce. Cotton seeds are usually sold to cotton oil mills for conversion into a number of important and valuable products, but in some cases they may be saved for planting purpose. The fiber the more valuable products and the design and operation of cotton gins are usually oriented towards fiber production. In essence, the modern cotton gin enhances the value of the cotton by separating the fiber from seed and by removing objectionable foreign matter, while preserving as nearly as possible the inherent qualities of the fiber.
Optimization of ginning machine for minimizing mass without affecting the structural stability has become important in the recent designs. In addition, designers have been practicing to remove some material in the plate platform area by analysis. This mass removal can be obtained without compromising the structural integrity. This procedure is illustrated in this report by using optimization code, Altair Optistruct for optimization of linear structures and using Hype mesh platform as the main finite element modeler.
Until recently, the dynamic stress field under nonlinear conditions is determined using energy methods and one dimensional beam models as given by (Rao and Vyas, 1996). A serious disadvantage in this approach is the inability to model the stress field in the regions of discontinuities or stress raisers. Today's commercial finite

element codes can handle large mesh sizes and can be used as solvers not only for an accurate assessment of the stress and strain field but also for applications in optimization.

Optimization has become a necessity in the recent years to achieve an optimal design in stress or strain, stiffness and weight etc. In earlier practices, dedicated codes were developed to achieve a specific optimization problem. Bhat et. al, 1982 used the method of feasibility directions to achieve optimum journal bearings for minimum unbalance response [1]. Optistruct has been developed recently to perform linear structural optimization and successfully applied for topology, topography, gauge and shape optimizations of automotive and airframe structures which discussed the weight optimization achieved in aircraft structures[2]. Hyper Study is a multi-purpose Optimization/ Stochastic tool used to perform wide cross-section of optimizations in Heat Transfer, Structures or multi physics problems using available commercial code platforms. With additional advances in mesh-morphing techniques. It has become somewhat easier in shape optimization.

Prior to 1600 primitive methods of Ginning i.e. “Pinch Ginning”, “Foot Roller Gin” and “Wooden Roller was used. The Charkha method of ginning, a true roller gin with small diameter pinching rollers that took the fiber from the seed without crushing, has been thought to have been named from Sanskrit whence came the term “Jerky” (which has long been spelled charka). The Charkha Gin, which was used for centuries in India, employed a pair of small counter-rotating wood or steel rollers to pinch and pull fibers from the seeds [3].

In 1742, M. Dub riel l, a French planter in Louisiana, had invented an improved roller gin that had greater length of rollers and more capacity than other gins then in use [4]. In the Mississippi-Gulf areas, considerable publicity accrued to a Mr. Krebs of Pascagoula who invented a roller cotton gin having a daily outturn of some 70 pounds of ginned lint, while competing units could only deliver approximately 30 pounds. In a history of Florida, Captain Roman of the British Army was quoted as saying that the Krebs roller gin had foot treadles and two well-polished, grooved iron spindles set into a frame approximately four feet high [5].

In 1777, Kinsey Burden of Burden's Island, South Carolina, constructed a roller gin that was made from old round gun barrels. These rollers were fastened at the ends on suitable grunions, and the unit claimed a daily capacity of 20 pounds. This unit was currently dubbed the “barrel gin,” and was said to have been quite popular in the Carolinas, Georgia, and Florida [6]. In 1793 – The northern-born, Yale-educated Eli Whitney invented the cotton gin with wire teeth that pulled the fiber from the seeds while visiting a Georgia Plantation, Gin makers and planters eventually substituted fine-toothed circular saws for Whitney's wire teeth later on saw Gin became dominant after Southern manufacturers developed more incremental improvements [7].

In 1840,a roller gin patent was issued to Fones McCarthy, Demopolis, Marengo County, Alabama, This new type of roller gin which his invention provided became as popular in most countries as the Whitney saw gin was in USA. The British refer to the gin as the McCarthy gin. The McCarthy ginning roller was much greater in diameter than charkha type roller and hence had greater capacity from the start. The first McCarthy Gins used rollers that were of 4” in diameter and 3 Feet in length. By 1850, however, the roller increased in size to almost 7” diameter and their lengths shortly thereafter became standardized into 40 inches. Single Roller McCarthy Gins stayed at 40 inches in length almost universally until the 1940 Era of New Roller Ginning Practices, for one or more of the major elements in McCarthy roller gin. These inventions endeavored to overcome some of the roller ginning troubles such as the destructive vibration of unbalanced moving knives, difficulties in adjusting and maintaining overlap and clearance settings, ginning roller bending or lack of stiffness, short life of roller covering, and seed crushing or chipping [8].

In 1889 – D.S. Chapin, Milford, Massachusetts brought out a roller gin designed that place the fixed knife horizontally above the Ginning Roller i.e. 90 degrees change from standard McCarthy practice [9].In 1890 – F.H. Chase, Havre hill, Massachusetts invented two significant roller gin improvement. First, he emphasized the construction of ginning roller by assembling leather or fiber disc with square holes clamped upon a shaft of rectangular cross section and second, he made up a 4 blade stripping roller or doffer to operate adjacent to the ginning roller [10].In 1894 – D.F. Goodwin, Valdosta, Georgia made a design of Double Roller Gin in which one roller was placed above the other, but employing the standard McCarthy reciprocating knife and other conventional features [11]. In 1895 – S. L. Johnston, Boston, Massachusetts, designed a roller gin that was upside down to the McCarthy conventional design. He reversed the position of the fixed and moving knives and added a sort of comb at right angles to the moving knife blade on the cotton feeding side so that it would stir up the seed cotton better [12].During 1895 and 1922 various improvements in single roller gins and double roller gins were taken up. Double Roller Gins, other than the American Foss, have usually employed somewhat different methods of rocking their central assemblies of combined knives and grids so that both rollers are in constant operation. However, British made Mddleton gins, Platt Brothers Company Gins were widely accepted [13]. In 1927 –A patent of Volkart improved upon Double Roller Gin made by Monforts M. Gladbach (Germany). This Volkart type Double Roller Gin has further been improved upon greatly in India by Bajaj Steel Industries Ltd., during 1963 to 2008 [14].

In 1960, the Rotary Knife Gin Stand (Rotobar) which operated at a capacity at 4-7 times that of the McCarthy Gin (Leonard 1970) was introduced. The Rotary Knife Gin Stand uses a large diameter roller and stationary knife to exert a pulling action on the fibers in a manner very similar to that of the McCarthy Gin. However, rather than having a reciprocating knife this roller gin stand utilizes a small diameter lighted roller to provide the necessary seed pushing action at the point of ginning [15].In 2000, Mr. Keith Thompson of Templeton Process Developments Limited, Lincoln shire U.K. tested a gin named "Templeton Rotary Gin" however due to feeding problems this gin could not be commercialized. As a matter of fact after the civil war, the technology evolution in respect of ginning factories proceeded forward with the focus no longer being on basic ginning mechanism but on combining gin with auxiliary functions, a folding of systems in the super-system into a single integrated device. Combination feeder, gin stand and condensers with dyers became common .Elaborate lint handling systems using belts and air driven flues appeared by the end of the nineteenth century [16].

II. TYPES OF GINS

A. *Saw Ginning*

Saw Gin stands typically have 30.5 to 45.7 cm diameter saws spaced from 0.5 to 1 in. apart with as many as 198 saws stacked on a single mandrel. Each of these saws project through ginning ribs, grasp the fiber and pull the fiber from the seed as they are too large to pass through the opening in the ginning ribs. The diameter of seed generally follows a normal bell shaped distribution, and occasionally a small seed escapes the gin stand and is removed by the moving sections of the gin stand or by a subsequent lint cleaner. The capacity of a single gin stand has increased from less than one bale per hour to more than 15.In the United States, gin plants typically have three or four gin stands per plant and process rates range from a few to over 100 bales per hour. Further, Saw Gin is used in China, Australia, Greece, Pakistan, Uzbekistan, Brazil and West Africa etc. The major disadvantage of Saw Gin is the lower length of fiber and requirement of compulsory deleting of seeds, left out fiber contents being higher on seed [17].

B. *Roto Bar or Rotary Knife Roller Gin*

A roller cotton gin including a ginning roller and a stationary knife to which seed cotton is conveyed by the friction surface of the ginning roller for separating lint fibers from the cotton seed, and a rotary stripping blade divide adjacent the stationary knife having blades forming channel-like pockets there between for receiving the seed cotton deposited on the surface of the ginning roller and advanced to the zone of the stationary knife. The blades of the stripping blade device extend radials from a center shaft to span the width of the gin and are arranged in a one turn spiral path about the center shaft, and the stripping blade device has a diameter which is a small fraction of the ginning roller diameter and rotates at a speed causing the surface speed of the blade edges to be approximately the same as the surface speed of the ginning roller such as to restrain seeds in the channel-like pockets while the seeds are advanced over the edge of the stationary knife from the "pinch point" to a "release point" while the ginning roller strips lint from the restrained seeds and then releasing the seeds from blade restraint at the release point before they are pushed beyond the length of the fibers attached at the "pinch-point" (after they travel about ½ the staple length beyond the knife edge) to return to the knife edge before the next blade applies advancing force to the seed and thereby withdraw substantially all the fibers from the seed. An auxiliary feed control roller for providing more even feed to the blade device and comb structure to return un-ginned seeds to the ginning zone are also disclosed. This technology is having major disadvantages of seed cut and un-ginned cotton going with seeds [18].

C. *Single Roller Gin*

The McCarthy roller gin utilizes a leather or composition roller to draw the fibers between a fixed knife and the roller. The pulling action of the roller on the fibers combined with the pushing action of moving knife are required to remove the fibers from each seed. The seed then falls through a seed grid and the fibers are removed from the roller by a rotating doffer. Single Roller ginning has long been the preferred method for ginning extra-long-staple, fine-fibered Sea Island, Egyptian, American-Egyptian, and Pima cottons (Bennett, 1956). While it is possible to gin these types of cotton with a saw gin, the resulting quality is substantially lower than that obtained with roller gins. Saw Ginning tends to decrease the fiber length of these types of cotton and to greatly increase their net content while one major disadvantage of the McCarthy Roller Gin is its low ginning capacity [19].

D. *Double Roller Gin*

In a double roller (DR) gin, two spirally grooved leather rollers pressed against a stationary knife with the help of adjustable dead loads, are made to rotate in opposite direction at a definite speed. The three beater arms (two at end and one at the center of beater shaft) are inserted in the beater shaft and two knives (moving knives) are then fixed to the beater arms with proper alignment. This assembly is known as beater assembly, which oscillates by means of a crank or eccentric shaft, close to the leather roller. When the seed cotton is fed to the machine in action, fiber adhere to the rough surface of the roller and are carried in between the fixed knife and the roller such that the fibers are partially gripped between them. The oscillating knives (moving knives) beat the seeds from top and separate the fiber, which are gripped from the seed end. The process is repeated a number of times till all spin able fibers are separated from the seeds, which are carried forward on the roller and doffed out of the machine. The ginned seeds drop down through the slots provided on seed grid, which is part and parcel of beater assembly, which also oscillates along with the moving knife. (P.G. Patil, GTC, CICR). In this ginning mechanism fiber comes out from the bottom side and falls either below on the floor for manual collection or in the Lint Flue Chute for Pneumatic Conveying for a series of Double Roller Gins or falls on a Lint Slide for conveying by Belt Conveyor fitted along a series of Double Roller Ginning Machines in the modern ginnery [20].

There are various models of double roller ginning machines available, however two models, one based on British Middleton Model and second based on Volker and Montfort’s M. Glad batch model, are commercially used in India. The Vol kart and Montfort M. Gladbeck model is the most popular among the ginneries. Out of about 70000 Double Roller Gins about 65000 are that of Volker and Montfort’s M. Gladbeck model type improved Double Roller Ginning Machines and majority of them are manufactured by Bajaj Steel Industries Ltd. Nagpur India. Against about 32 million bales produced in India around 30 million bales are produced on Double Roller Ginning Machines only. Further, Double Roller Gins are extensively used in Tanzania, Uganda, Zambia, Zimbabwe, Myanmar, Egypt, etc. At present over 40 million bales of cotton are ginned on Double Roller Ginning Machines, in these countries which constitutes about 30% of total world cotton production. This technology is having various advantages i.e. higher production as compared to McCarthy Gin, retention of all fiber properties similar to McCarthy Gin, possibility of setting up a smallest size ginning factory i.e. half bale per hour to largest size ginning factories i e. 60 bales per hour. In India, at present, large volume i.e. 2000 bales per day plants are setup using multiple modules of 35 bales per hour capacity while smaller ginneries are also setup conveniently using this technology in large numbers i.e. over 5000 ginneries [21].

Fig.1. A photograph of DR Gin with Lint Suction System from Each Gin

III. OPTIMIZATION TYPES

Optimization is the act of obtaining the best result under given circumstances. In design, construction, and maintenance of any engineering system, engineers have to take many technological and managerial decisions at several stages. The ultimate goal of all such decisions is either to minimize the effort required or to maximize the desired benefit. Since the effort required or the benefit desired in any practical situation can be expressed as a function of certain decision variables. Optimization can be defined as the process of finding the conditions that give the maximum or minimum value of a function.

A. Modular Optimization

For modular optimization the whole structure is divided into regions. Usually the regions represent the parts of a full body in white, but regions also can be defined from subassemblies like front longitudinal rail shock tower, dash panel b-pillar Fig. or from the separate zones of a tailor rolled blank. For body in white development modular thickness optimization on part level is common practice. Therefore modular optimization is expected to result in realistic weight reduction potential within the chosen concept.

Modular optimization is conducted using Na-strane solution 200 with separate thickness variables for each module, part, or zone of a tailor rolled blank. Typically the number of thickness variables ranges from 10 to 1000. Minimizing the weight is the objective of modular optimization, and constraint conditions ensure that stiffness targets are reached satisfying all manufacturing constraints .Depending on the balance of the structural concept and the number of thickness variables the stiffness of the different load cases reaches the target value exactly or exceeds the target due to cross-load case benefits of some structures. For an optimal structure all targets are reached exact and fully balanced without additional stiffness in any load case, sinceadditional stiffness is expected to re fulfillment of stiffness targets and manufacturing imply additional weight reduction potential [22]

B. Global Optimization

Global optimization is very similar to modular optimization procedure. It is also conducted using Nastran solution 200 but with only one global thickness variable. Again minimizing the weight is the objective, and constraints ensure requirements.

Even with the minimal possible number of thickness variables – one global thickness – the structural targets can be achieved. Particularly for global optimization the concept of structural balance is of importance. The global thickness of the structure or the part is determined by the weakest spot of the over-all structure. The evaluation of the balance between the load cases allows for the identification of the weakest load case and shows its contribution to the other load cases. This information is very helpful to improve the structural concept by further balancing the structures related to each load case.

C. Local Optimization

Local optimization indicates the far end of number of thickness variables. For each design element at thickness variable is defined. With the small contribution of the single element to global weight and global stiffness the small sensitivities to single element thickness cause numerical uncertain ties resulting in non-optimal thickness distributions at direct weight optimization. For this reason optimization procedure is changed to 2D topology optimization using Altair Optistruct. There also is one thickness variable per element (defined by element relative density) considering the basic manufacturing restrictions of lower and upper thickness bounds. But objective is replaced by minimizing the weighted compliance for a given amount of material. The main advantage of this method is the higher sensitivity of the objective function to the single element. Within one optimization run the best distribution of the given material with respect to the objective is calculated. Using the parameter wolfram the amount of material available is varied until the constraint conditions ensuring the stiffness targets are satisfied without further weight reduction potential. The maximum possible weigh reduction is obtained, if convergence to minimum compliance is reached in the same iteration as all constraint conditions are satisfied for the first time .A constraint condition plot visualizes the influence of volume fraction, Fig. 2. For low volume targets of several load cases cannot be achieved. With additional material available topology optimization improves preferably the load cases violating constraint conditions. After the weakest load case reached thetarget stiffness the remaining material is put to the load cases with the highest effect on minimizing the weighted compliance. For fulfillment of targets there is no need for this remaining material. Maximum weight reduction potential is obtained with the weakest load case just satisfying the stiffness target.

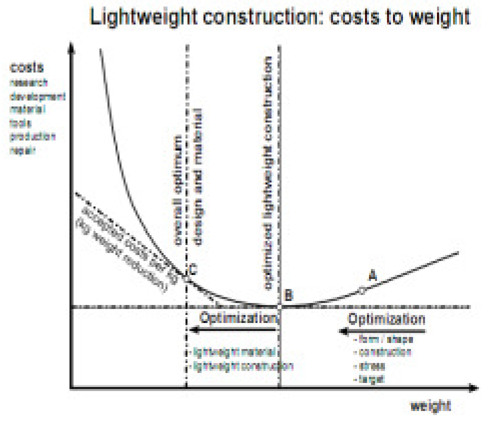

Fig. 2. Relationship between cost and weight

Optimization methods were developed to have lighter, less cost and may have better strength too. Many optimization types, methods and tools are available now a days due to the revolution of the high speed computing and software development. There are four disciplines for optimization process.

i. Topology optimization: it is an optimization process which gives the optimum material layout according to the design space and loading case.

ii. Shape optimization: this optimization gives the optimum fillets and the optimum outer dimensions.

iii. Size optimization: the aim of applying this optimization process is to obtain the optimum thickness of the component.

iv. Topography optimization: it is an advanced form of shape optimization, in which a design region is definedand a pattern of shape variable will generate the reinforcements.

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Shape optimization was developed using optimization techniques such as Genetic Algorithms (GAs). Shape optimization is applied to many fields such as Computational Fluid Dynamics (CFD) especially aerodynamics and electrical engineering field as well as mechanical engineering, for example : strain gauge load cell , a cantilever beam and cam Finite element method used for many type of analysis, such as linear analysis, nonlinear analysis, fatigue analysis and another types. FE analysis was developed to solve the optimization process such as Optistruct linear solver. This research aims to contribute to the development of structural design and weight reduction of ginning machine components using Weight optimization by the gradient based method. Optimization process for this work was conducted using OptiStruct solver in order to reduce the weight of the component which will reduce the cost with respect to the weight production process. Fig. 2.shows that the optimized weight and cost is at point B, where weight and cost is very less than the other points. The point C shows that at that point the weight of system tremendouslyreduced but the cost is more that is uneconomical

D. Engineering Application of Optimization

Optimization, in its broadest sense, can be applied to solve any engineering problem. Some typical applications from different engineering disciplines indicate the wide scope of this subject

- Design of aircraft and aerospace structures for minimum weight
- Finding the optimal trajectories of space vehicles
- Design of civil engineering structures such as frames, foundations, bridges, towers, chimneys, and dams for minimum cost
- Minimum-weight design of structures for earthquake, wind, and other types of random loading
- Design of water resources systems for maximum benefit
- Optimal plastic design of structures
- Optimum design of linkages, cams, gears, machine tools, and other mechanical components
- Selection of machining conditions in metal-cutting processes for minimum production cost
- Design of material handling equipment, such as conveyors, trucks, and cranes, for minimum cost
- Design of pumps, turbines, and heat transfer equipment for maximum efficiency
- Optimum design of electrical machinery such as motors, generators, and transformers
- Optimum design of electrical networks
- Shortest route taken by a salesperson visiting various cities during one tour
- Optimal production planning, controlling, and scheduling
- Analysis of statistical data and building empirical models from experimental results to obtain the most accurate representation of the physical phenomenon
- Optimum design of chemical processing equipment and plants
- Design of optimum pipeline networks for process industries
- Selection of a site for an industry
- Planning of maintenance and replacement of equipment to reduce operating costs
- Inventory control
- Allocation of resources or services among several activities to maximize the benefit
- Controlling the waiting and idle times and queuing in production lines to reduce the costs
- Planning the best strategy to obtain maximum profit in the presence of a competitor

IV. CADMODELLING AND DESIGN PROCEDURE

Computer Aided Design (CAD) could be defined as the use of computer system to assist in the creation, modification, analysis or optimization of a design. The computer system consists of the hard ware and the software to perform the specialized design function required by the particular user firm. The CAD hardware typically includes the other peripheral equipment. The CAD software consist of the computer program to implement computer graphics on the system plus application program to facilitate the engineering function of the user company.

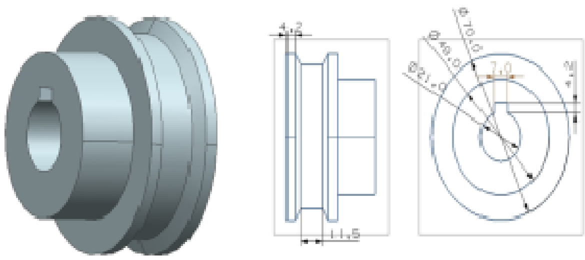

Fig. 3. Smaller Pulley

NX7 also known as NX Unigraphics or usually just U-G, is an advanced CAD/CAM/CAE software package developed by Siemens PLM Software. It is used, among other tasks, for -Design (parametric and direct solid/surface modeling) Engineering analysis (static, dynamic, electro-magnetic, thermal, using the 'Finite Element Method'). Manufacturing finished design by using included machining modules. NX is a direct competitor to Creo/Pro, CATIA, Solid Works and Autodesk Inventor

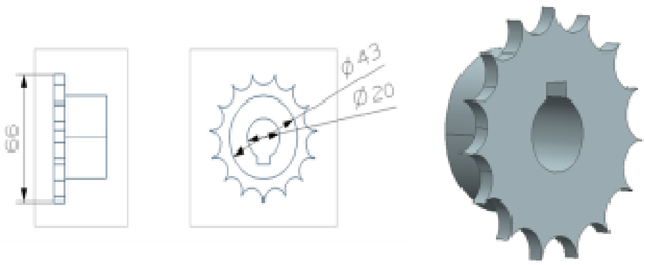

Fig. 4. Smaller Sprocket

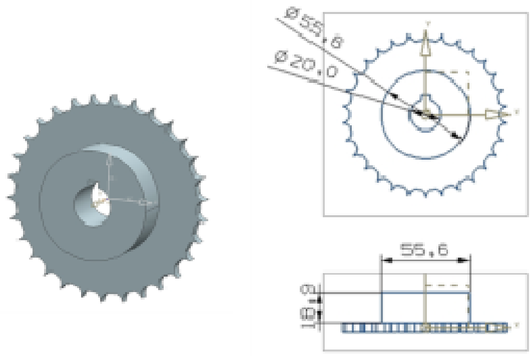

Fig. 5. Bigger Sprocket

V. FINITE ELEMENTAL ANALYSIS MODELLING

The finite element method (FEM) (its practical application often known as finite element analysis (FEA) is a numerical technique for finding approximate solutions of partial differential equations (PDE) as well as integral equations .Finite element method (FEM) is a numerical method for solving a differential or integral equation. It has been applied to a number of physical problems, where the governing differential equations are available. The method essentially consists of assuming the piecewise continuous function for the solution and obtaining the parameters of the functions in a manner that reduces the error in the solution. In this article, a brief introduction to finite element method is provided. The method is illustrated with the help of the plane stress and plane strain formulation.

FEA uses a complex system of points called nodes which make a grid called a mesh. This mesh is programmed to contain the material and structural properties which define how the structure will react to certain loading conditions. Nodes are assigned at a certain density throughout the material depending on the anticipated stress levels of a particular area. Regions which will receive large amounts of stress usually have a higher node density than those which experience little or no stress. Points of interest may consist of: fracture point of previously tested material, fillets, corners, complex detail, and high stress areas. The mesh acts like a spider web in that from each node, there extends a mesh element to each of the adjacent nodes. This web of vectors is what carries the material properties to the object, creating many elements.

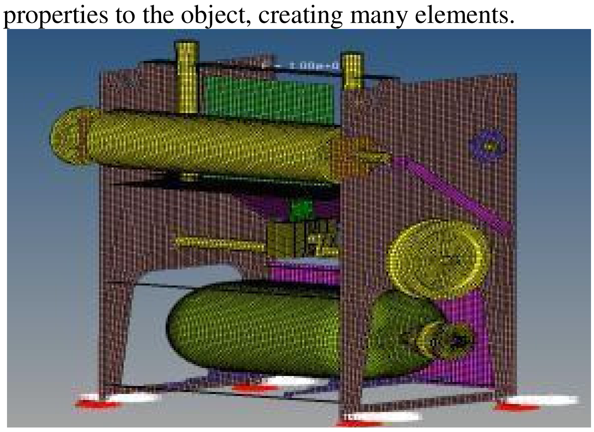

Fig. 6. Finite Elemental Analysis Model

VI. Results and Discussion

Factors that are taken into consideration for optimizing the design of “cotton seed separation machine” are:

1. Belt tension T1= 153.93 N and T2=8.70 N
2. Tension created by chain or sprocket
3. Motor mass (25 kg) 245.25 N
4. Self-weight of structure

The overall design OPTIMIZATION OF COTTON SEPERATION GINNING MACHINE is optimize for its mass and thickness of metal component.

Casting component were ignore for optimization since the optimize result has tittle relevant as per as design modification of casting component concerned geometry consideration in terms of actual dimensions capture were compromised at certain location with respect to certain component because it was not feasible to capture certain dimension or component using FINITE ELEMENT. Hence an appropriate FEM was created to represent the particular dimension or component. This approximation has a very little significance on the optimize result. Optimization for the structure was carried out under static condition under an assumption that there was zero relative motion between any of the component of the assembly. Hence, even a bearing was captured using continuous 2D to 3D connectivity. For optimizing structure topology optimization was used and optimization is carried out using alter optistruct solver or optimizer

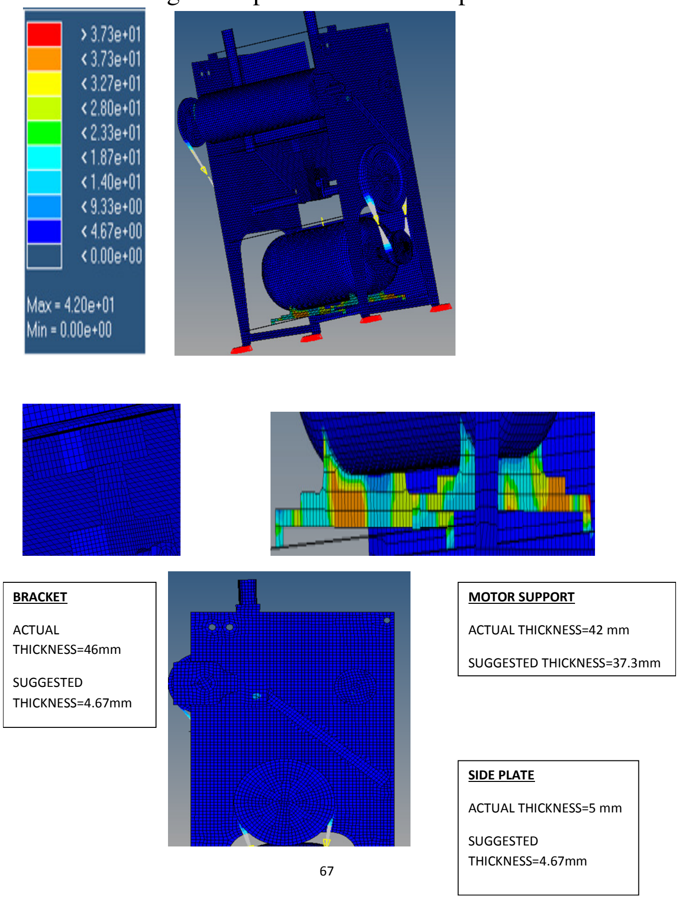

Fig. 7. Iteration results

Table 1. Result table

ITERATION NO	BRACKET THICK(mm)	SIDE PLATE THICK(mm)	MOTOR SOPPORT THICK(mm)
00	24.9	3.22	24.9
01	16.8	4.2	33.6
02	9.33	4.67	37.3
03	9.33	4.67	37.3
04	4.67	4.67	37.3
05	4.67	4.67	37.3
06	4.32	4.32	34.6

07	4.63	4.63	37.1
08	9.33	4.67	37.3
09	9.33	4.67	37.3
10	8.9	4.48	35.8
11	9.16	4.58	36.6
12	8.28	4.14	33.1
13	8.35	4.17	33.4
14	8.27	4.14	33.1
15	8.32	4.16	33.3
16	8.29	4.14	33.1
17	8.31	4.16	33.2
18	8.33	4.16	33.3
19	8.35	4.17	33.4
20	8.38	4.19	33.5
21	8.41	4.20	33.6
22	8.44	4.22	33.8
23	8.49	4.24	33.9
24	4.34	4.34	34.7
25	8.78	4.39	35.1
26	8.90	4.45	35.6
27	8.75	4.38	35.00
28	8.85	4.34	35.4

VII. CONCLUSION

Objective of our work was to optimize the design of ginning machine in terms of its weight. In order to reduce the weight a save structural design was sorted. Current model of ginning machine is over designed which makes it bulky and hard to handle. Hence, optimization of mass in terms of removal of material was the only option available which would reduce the weight of the machine. The optimization was carried out by using two design variables viz mass and thickness. The overall structure was analyzed for change in mass by reduction of component thickness. Since a ginning machine is pre-loaded with several structural forces, such as bolt-tension, riveting tensing, weld stiffness etc, which are hard to evaluate, the design was optimized for following conditions;

i. Structural constraints
ii. Belt and chain tensions
iii. Motor weight
iv. Self-weight of structure

After carrying out the optimization we've concluded that for the above mentioned conditions there are 30 feasible solutions (shown in the table). Each of these solutions is good enough to provide good structural stability under above mentioned conditions, which can be found out by carrying out a linear static structural analysis of the machine under above mentioned conditions.

As per our observation the side plates were the critical components bearing the load of most of the machine components. But as can be seen from the results there are three regions of concern which can be seen in the results. Hence, the optimized solution shows thickness variations in these three regions for the above mentioned condition. And all the 30 results hold the same kind of structural stability as the current model does whereas the mass is significantly lesser as compared to the actual model. Thickness reduction of side plate, if we consider only side plate

Minimum thickness in table = 3.11mm
Maximum thickness in table = 4.67mm
If we take average thickness we get = 3.89mm
Actual thickness =5.00mm
Therefore total Reduction in thickness =1.11mm

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