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Comparative Analysis between Structural Steel & Cast Iron for Design and Analysis of Dehulling machine for Biba using ANSYS

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Abstract - *The research is mainly focused on removing the hulls from its beans. In this work a dehuller is designed using ANSYS software. The machine will be useful in rural area.Stresses produced are calculated and regions were found which are more susceptible to failure. The same design is compared by selecting structural steel and cast iron as material of design. This research will guide to study the chances of failure which may happen during the production hours. In this work a dehuller for biba dehulling is designed using ANSYS software. Stresses produced are calculated and found out regions which are more susceptible to failure. The same design is compared by selecting structural steel and cast iron as material of design.*

Key Words: *Dehuller, ANSYS, **Structural Steel, Cast Iron***

1. INTRODUCTION

Biba (Biba) is a dry land fruit crop of Anacardiaecae family. It is found in India, Malaysia, and Australia, etc. In Maharashtra, production of biba is about 1600 tons/year and in M.P., A.P. and Orissa, is about 700 tons. Fruit is drupe with seed of purplish black color and orange red, fleshy and cup shaped hypo crop, eaten raw, by roasting or by drying. The per carp abounds in a black, oily bitter and highly vesicant juice known as Bhilawan Shell Liquid (BSL, 46 % by wt) is a rich source of phenols and having number of industrial and medicinal uses. The seed kernels present inside a hard shell has an almond like taste is eaten to stimulate mental ability and for aphrodisiac properties. Also, it is used for bodybuilding and strengthening foods in winter season.

Many researchers have tried to design a biba (marking nut) dehuller but yet suitable dehuller has not been developed. Traditional biba (marking nut) dehulling process is very tedious, difficult and accompanies with injuries to the workers. The ugly markings are remained on the body parts so that only age-old tribal women are engaged in this work. Also the efficiency and capacity of the traditional dehulling is very low. But the kernel and BSL- Bhilawan Shell Liquid are costly items in the market as they are used for medicinal purposes. Traditional biba dehulling process is very tedious, difficult and accompanies with injuries to the workers. The ugly markings are remained on the body parts so that only age-old tribal women are engaged in this work. Also the efficiency and capacity of the traditional dehulling is very low. But the kernel and BSL are costly items in the market as they are used for medicinal purposes. Outer layer of marking nut per carp is soft in which blackish brownish oil is stored in small groove like inter linked shells. The inner layer is hard in which seed kernel is stored. It is curved at the center, making 'C' shape and the edges are thin. Separation of the kernel is a tedious job. Marking nut tremendously vary in their size, length, width, thickness and shape. Knowing the typical physiology of marking nut, it seems very difficult to develop a dehuller for it. Therefore, in our project work we are trying to design fully automated dehulling Machine.

2. LITERATURE REVIEW

The literature review focuses on the research carried out to develop Conceptual Prototype of dehulling Machine for marking nut – BIBA.

A.S. Ogunlowo and R. Bello (2005) [1], This work has discussed the effective threshing of minimum grain loss, improved threshing capacity and efficiency was achieved with a dynamically stable thresher designed and fabricated with a power rating of 2.9kW, belt speed of 12m/s and cylinder speed of 5.03m/s. A horizontal centrifugal fan was used with straight blades. The spike tooth (rubber beaters) were arranged spirally to serve as conveyor. The machine has an efficiency rate of 96.58% and the threshing capacity of 27.58kg/hr for cowpea; at an average moisture content of 13.16 %. (dry basis), and concave-beater clearance of 9mm± 0. 5. Separation losses were minimal.

A.Ibrahim and A. P. Onw ualu (2005) [2], This work has discussed a critical appraisal of technologies for oil extraction from oil bearing agricultural products is presented. Different types of oil- bearing agricultural products are discussed. The products include; groundnut, coconut, shea nut, castor, sunflower, sesame, oil-palm, etc. This work has also discussed the pre-processing conditions including the removal of hulls and shells, pre-processing conditioning such as size reduction, moisture content adjustment, heat treatment and pressure application, as well as the methods employed in the extraction, namely; traditional and modern (improved) methods.

C.U. Orji (2005) [3], This work has discussed the design of a motorized low-cost extrusion cooker for full fat soy-meal production from soybean is presented. The machine was designed based on the high shear single screw extrusion systems, with segmented screws, which has three major

zones: feeding zone, compression zone, and melting zone. It has a capacity of 187kg/hr (1.5 tons/day), power requirement of 20hp, screw rotation of 450rpm and a cost of seven hundred thousand Naira (N700,000.00) as against two million Naira (N2,000,000.00) for imported unit. The Chemical and Microbial analysis of the full fat soy meal satisfies the standard (BIS).

Ashwini kumar A Raut et all (2007) [4], Bhallatak has been used for medicinal purposes since ancient times. The toxicity of bhallatak precludes its mega scale production particularly as a medicine at the industial level. It is important to understand the signification of Ayurveda inspired invistigation of this traditionally acclaimed medicinal plant

T. K. Mohanta et al. (2010) [5], has explain Semicarpus anacardium L.f. is a medicinal plant that belongs to the family of Anacardiaceae and is used by tribals of Similpal Biosphere Reserve, Orissa, India for various ailments. Aqueous and organic solvent extracts of the plant were screened for antimicrobial (disc diffusion method) and phytochemical properties. The petroleum ether (PEE) and aqueous extract fractions (AQE) showed inhibitory activity against Staphylococcus aureus (10 mm) and Shigella flexneri (16 mm) at 100 mg/ml, respectively. While chloroform extract showed inhibition against Bacillus licheniformis, Vibiro cholerae and Pseudomonas. aeruginosa. The ethanol extract showed inhibition to Pseudomonas aeruginosa and S. aureus. The oils extracted from nuts did not exhibit any antimicrobial activity. Alkaloids, tannins, saponins, flavonoids, anthraquinone and volatile oils were detected in nuts aqueous extracts with only triperpenoid in PEE and steroid in both PEE and chloroform extracts. The phytochemicals such as alkaloids, flavonoids, tannin and anthroquinone were present in oils extracted from nuts. The antibacterial activity of the nut extracts of Semicarpus anacardium is due to AQE and PEE-extractable compounds. However, the active component (s) responsible for the antibacterial activity can be isolated.

A.Sharma et al. (2010) [6], has explained the essential oil from nut of S.anacardium was extracted by hydro-distillation method in a Clevenger type apparatus. The significant potential of Semecarpus anacardium nut oil concludes that it could serve as a source of antimicrobial agents.

Choudhari CV and Deshmukh PB (2012) [7], has deals with the assessment of effect of SAE onbiochemical parameters (Total proteins, glucose, glycogen, cholesterol and Mg) and activity of GOT, GPT, LDH, SDH and AChE enzymes of brain of albino rat. Experimental albino rat after oral treatment of SAE showed alteration in studied parameters indicating the adverse effect on brain compared to control group. Outputs of the study signify the need of safe environment, safer extraction process and a proper training to those workers.

Srivastava AK and Sudhanshu Kumar (2013) [8], Rat has always been a problem for agricultural fields. Farmers of Jharkhand are always troubled by these rodents who damage grains in fields or in store. The cost of various chemicals to kill or repel rat is beyond the affordable limit of the poor tribal farmers in Jharkhand. Farmers of Panch-Pargana area of Jharkhand have developed an indigenous way to get rid of rats from their fields and prevent damage caused by them below economic injury level. Bhelwa (*Semicarpus anacardium) seed oil is used for this* purpose. Though the practice is quite old and time tested it is still not known to modern scientific world. The aim of this communication is to study the detailed method of rat population management through the Bhelwa seed oil.

3. APPLICATIONS OF BIBA

The nut is used as dyspepsia marking nut is useful in anemia, fever, pimples, psoriasis, sore throat, splenetic, sprain, toothache, wart and tumor. The wood of this plant is also recognized as firewood. The Semecarpus anacardium tree is a native of all India. Its nuts are black, smooth, shining, and flattened on both sides. The nut rests upon a thickened stalk (peduncle). The per carp or shell of the nut is composed of two lamina ; between them are cells which contain the black, corrosive, resinous juice, which is employed to mark cotton cloth. The color is improved and prevented from running by a little mixture of quicklime and water, whence its name of marking nut. The tribe of plants to which it belongs abounds in plants yielding a blackish, acrid, and resinous. Medicinal Uses Recent studies have shown the fruit to be a good anti-inflammatory agent and effective in various types of cancers. It is also used against bacterial and fungal infections. And it is also used in some skin disease treatment.

4. OBJECTIVES FOR DEHULLING EQUIPMENT FOR MARKING NUT

1. To get seed kernel a valuable part, traditionally beating with stone does marking nut dehulling. In this process there is risk of injury due to splashing of BSL on body parts which forms ugly markings remaining forever. More breakage of seed kernel takes place which becomes blackish after some time and fetches low price in the market. To reduce the time required breakage of kernels and other difficulties in marking nut dehulling.
2. The objectives of research work are to design and fabricate dehulling equipment for marking nut and to minimize the injuries and losses in traditional marking nut dehulling.
3. To develop Conceptual Prototype of dehulling Machine for Marking nut - BIBA
4. To Analyze Computer aided design analysis of Marking nut outer Shell.

5. PART ASSEMBLY OF MARKING NUT DEHULLER MACHINE

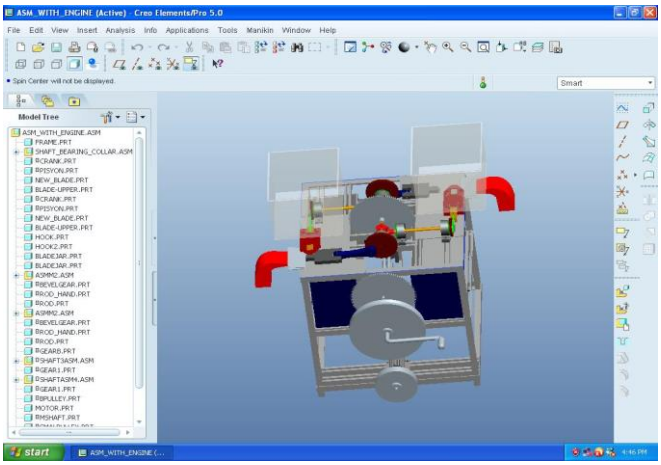

Fig.1. Part Assembly of Marking Nut Dehuller Machine

6. FINITE ELEMENT ANALYSIS USING ANSYS

Finite Element Analysis (FEA), also known as the Finite Element Method (FEM), is probably the most important tool added to the mechanical design engineer's toolkit in recent years. The development of FEA has been driven by the desire for more accurate design computations in more complex situations, allowing improvements in both the design procedure and products. The growing use of FEA has been made possible by the creation of affordable computers that are capable of handling the immense volume of calculations necessary to prepare and carry out an analysis and easily display the results for interpretation. With the advent of very powerful desktop workstations, FEA is now available at a practical cost to virtually all engineers and designers.

Solving a practical problem by FEA involves learning about the program, preparing a mathematical model, discrediting it, having the computer do calculations and checking results. Most often, more than one cycle through these steps is required. Time spent by the computer is a small fraction of time spent by the analyst, but the analyst must have an understanding of what the software is doing.

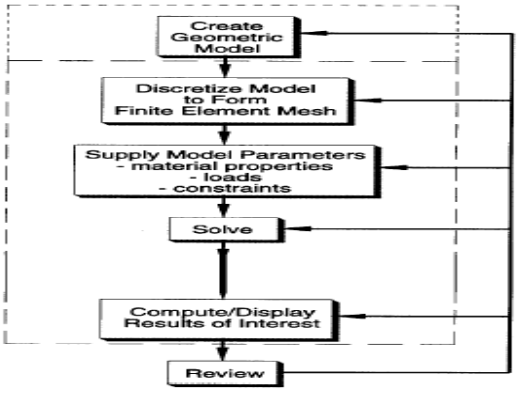

Fig 2. Overall steps in FEA Solution

7. Application of Boundary Conditions

A. Material Properties of both steel and Cast Iron

Table 1. Material Properties of Cast Iron and Structural Steel

Properties	Structural Steel	Cast Iron
Young's Modulus	2.e +011 pa	1.1 e + 011pa
Poissons Ratio	0.3	0.28
Tensile Yield Strength	2.5e + 008 pa	0 pa
Tensile Ultimate Strength	4.6e+008pa	2.4e+008pa
Compressive Ultimate Strength	0.pa	8.2e+008pa
Thermal Conductivity	60.5w/m0c	52w/m0c

8. Cast Iron and Structural Steel

A .Load Applied

Axial load has been applied in this case which is 100 N. This magnitude of load has been selected for a few genuine reasons explained ahead. The load on the each jar is 5 kg. hence this amounts to 10 kg in totality. And when this load is converted in Newton's it figures out as 100 N. The direction of the load is along z axis and it has applied in the direction at which the nut is being cut via blade. This has been clearly depicted in Fig.

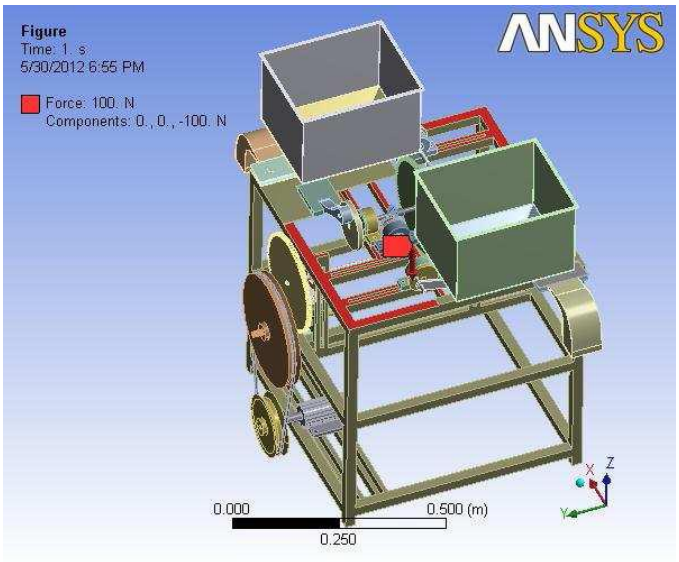

Fig 3. Load Applied (100 N)

B. Constraints (In the form of fixing the legs i.e. frame)

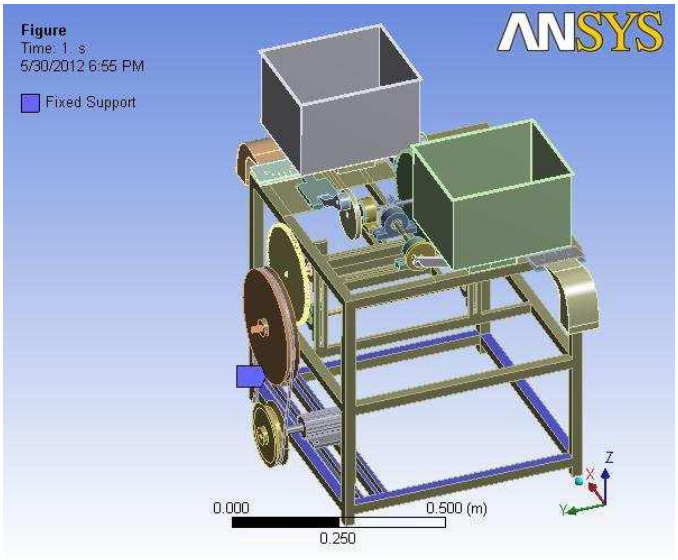

Fig 4. Constraints (In the form of fixing the legs i.e. frame)

C. Meshing

The total elements in meshing were 131400 where as the the number of nodes are 288631. Automatic meshing has been carried out in ANSYS and is shown in the Fig.

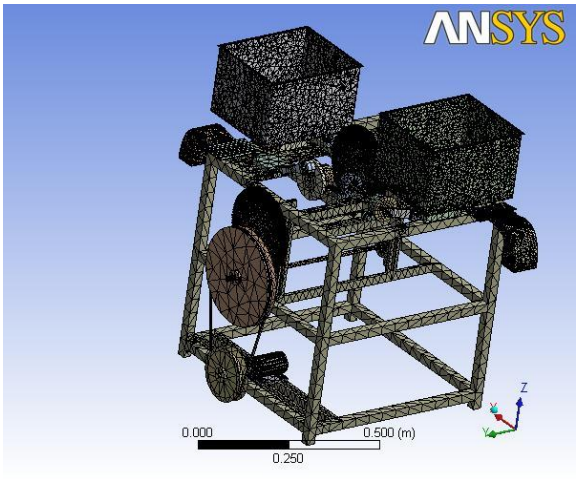

Fig 5. Meshing

9. RESULT AND CONCLUSIONS

1. FEA on Steel as a material for Dehuller Machine

The various factors under which steel has been analyzed are Deformation, equivalent stress, shear stress and vibration. They were discussed one by one below:

A. Deformation of Dehuller Machine (Steel) when subjected to static loading.

In the post processing mode in ANSYS we found that the maximum deformation occurred around Bevel gear and is clearly depicted in Fig. 5.1 in red colour shown below. As per the results obtained the maximum deformation was 5.02e-6 mts.

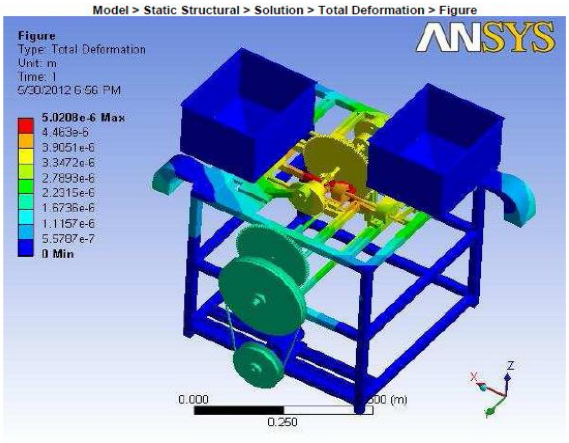

Fig. 6 Deformation of Dehuller Machine (Steel) when subjected to static loading

B. Equivalent Stress of Dehuller Machine (Steel) when subjected to static loading.

After running the solver in static structural analysis workbench the maximum value of equivalent strees worked out as 3.29 MPa. The strees regions are clearly visible in Fig. below

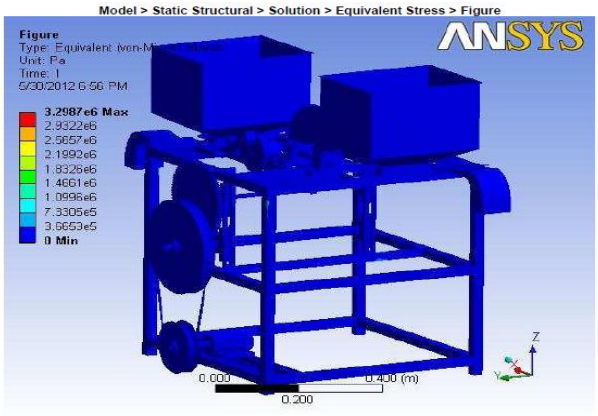

Fig. 7 Equivalent Stress of Dehuller Machine (Steel) when subjected to static loading

C. Shear Stress of Dehuller Machine (Steel) when subjected to static loading.

The magnitude of shear stress is also an important factor in the analysis of machines. After running the solver the maximum value of shear stress figured out to be 1.32 MPa. This can be seen in the Fig. below.

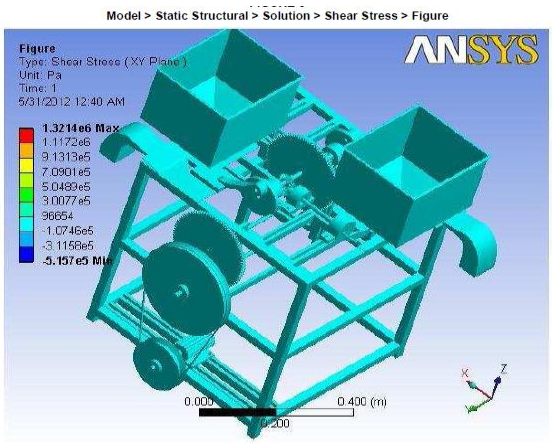

Fig.8 Shear Stress of Dehuller Machine (Steel) when subjected to static loading

D. Free Vibration Analysis (Steel)

The vibration analysis under four different conditions have been carried out 1.4102mt for frequency 6.3226e-003.

II. FEA on CI as a material for Dehuller Machine

The various factors under which Cast Iron has been analyzed are Deformation, equivalent stress, shear stress and vibration. They were discussed one by one below:

A. Deformation of Dehuller Machine (CI) when subjected to static loading.

In the post processing mode in ANSYS we found that the maximum deformation occurred around Petiseal1 (Piston Guide) and is clearly depicted in Fig. 9 in red colour shown below. As per the results obtained the maximum deformation was 5.0657e-006 m.

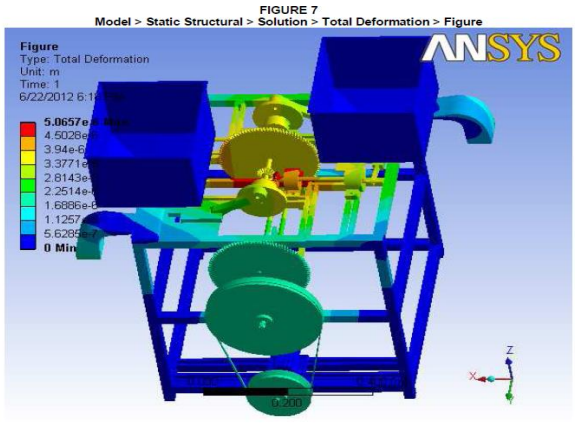

Fig. 9 Deformation of Dehuller Machine (CI) when subjected to static loading.

B. Equivalent Stress of Dehuller Machine (CI) when subjected to static loading.

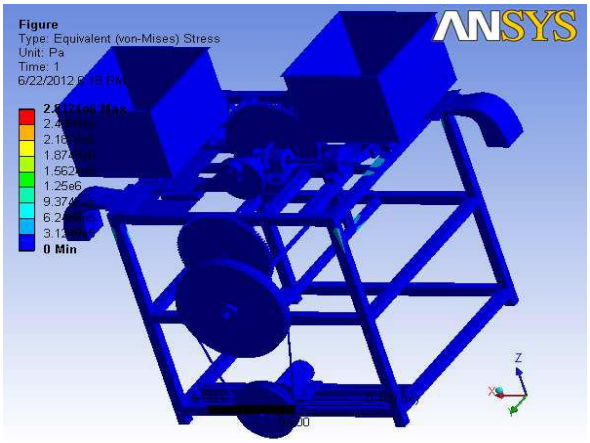

Fig. 10 Equivalent Stress of Dehulling Machine (CI) when subjected to static loading

C. Shear Stress of Dehuller Machine (CI) when subjected to static loading.

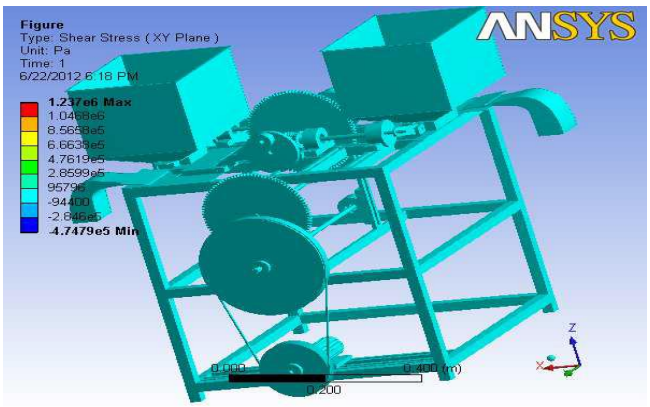

Fig.11. Shear Stress of Dehuller Machine (CI) when subjected to static loading

D. Free Vibration Analysis (CI)

The vibration analysis under four different conditions have been carried out 2.2057mt for frequency 5.1694e-003 Hz

III. Comparison of all output parameters (Eq. Stress, Def, Shear Stress, Vibration) for Structural steel and Cast Iron**.**

There is considerable difference in the structural behavior of the Marking nut Dehuller between axial fatigues loading. The results obtained with the analysis tool are quite comfortable and can be used to optimize the model. The Optimization carried out in analysis gives deep insight by considering optimum parameter for suggestion of modification in the existing Marking nut Dehuller. It has been found that maximum equivalent vonmises stress developed in structural steel as compared to cast iron (Table No.2). Therefore it is advisable to use cast iron for its manufacturing. Bevel gear of the system is most critical as stress developed in it is maximum.

Table 2. Comparative Analysis between Structural Steel & Cast Iron

S.N.	Output Parameter	Structural Steel	Cast Iron
1	Deformation	5.0208e-006 mt	5.0657e-006 mt
2	Equivalent Stress	3.2987e+006 Pa	2.8124e+006Pa
3	Shear Stress	1.3214e+006 Pa	1.237e+006 Pa
4	Vibration	1.4102mt for frequency 6.3226e-003 Hz	2.2057mt for frequency 5.1694e-003 Hz

10. FUTURE SCOPE & CONCLUSION

A lot has been done and still a lot has to be done in this field. In this project, only the static FEA of the Markingnut Dehuller has been performed by the use of the software Pro/E wildfire for cad modeling and ANSYS WORKBENCH 11.0 for Finite Element Analysis. This work can be extended to study the effect of loads on the Markingnut Dehuller under dynamic conditions. Experimental stress analysis (ESA) can also be used to calculate the stresses which will provide more reasons to compare the different values obtained.

Now days, a lot is being said about vibrational study of mechanical component and its important role in failure. So the study can be extended to the vibrational analysis of the Markingnut Dehuller. We can change the material of the Markingnut Dehuller for better result. Changing the geometry, but as it was the restriction from customer end, this is not covered in this project. So the need of the hour is the optimization of the Markingnut Dehuller which will lead to a revolution in the manufacturing sectors of the Agriculture firm.In this work, and after carrying out all sorts of analyses, it was concluded that the bevel gear has been the most affected part. It is this conclusion that urges us to further enhance the design parameters of bevel gear. This gear alone can be taken up as a project and its analysis can be carried out for a specific boundary condition.

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