STRUCTURAL ANALYSIS OF GROUND NUT OIL EXTRACTION MACHINE

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Abstract: Groundnut oil extraction involves removing oil content of the groundnut seeds. There is a misconception between groundnut oil & other vegetable oil used because of the inefficient processes of producing groundnut oil. The main aim is to provide analysis of designed automated groundnut oil extractor. The desired crushing effect at lower input is achieved by the low speed of the machine. The main components are electric motor, expellant unit, drains collector, hopper. The 3 D model was drawn with the help of CATIA software. The analysis will be carried out with the help of ANSYS software.

***Keywords* - Structural Analysis, CATIA, ANSYS**

I. INTRODUCTION

Groundnut oil expelling machine is an important device for oil recovery from groundnut seed in a roller mill, direct firing of barrel and pressing with an engine driven oil expeller. Expeller use a horizontal rotating metal screw, which feeds oil-bearing seeds into a barrel shaped outer casing with perforated walls. The seeds are continuously fed to the expeller, which grinds, crushes and presses the oil out as it passes through the machine. The pressure breaks the oil cells in the product and oil flows through the perforation in the casing and passes through the oil outlet and is finally collected with oil receiving container which situated directly bellow. The residue of the material from which oil has been extracted, are sent out through the cake outlet. Bigger units which process greater quantities of oil are available for use in larger mills. The percentage of oil extracted by expellers is nearly 90% depending upon the type and kind of products as well as the expeller being employed. The friction created by the products being pressed wears down the worm shaft and other internal parts, and also have the tendency of creating problem or causes failure of main shaft.

The need to produce a groundnut oil expelling machine arose even in the distant past due to the need to produce oil for domestic and commercial uses. Groundnut seed (*Arachis hypogea*), also known as peanut and earthnut, It is grown principally for its edible oil and protein rich seeds. The oil content of the seeds is between 45% and 55% depending on the variety. To remove the oil content from the groundnut seed, the process known as oil extraction, expelling or expressing is carried out. Groundnut oil extraction technologies involves machines that are developed to carryout sub-processing operations involved in traditional groundnut oil extraction. These machines are; shelling, roasting, de-skinning, milling and kneading machines. Also, there are machines that are developed to extract groundnut oil from the just shelled groundnut seeds, such as hydraulic press and screw press.

In our research we introduced the simulation in purpose of stress and displacement analysis of the expeller shaft of oil extraction machine. The expeller shaft is an important part of screw press as it supplies the pressure required for extracting oil from the raw material. It is found from observation that the failure of screw causes extra costs which is undesirable. In addition, excess stress, bending, displacement may cause major overhaul of the press. So to increase the life of screw press and efficient oil extraction it is necessary to find exact stress and bending of the screw blades. Also vibration analysis and self weight analysis of Domestic oil extraction machine is required. So to determine these, simulation is introduced which is performed by FEA (Finite Element Analysis) with ANSYS software.

II. OBJECTIVES

The main objective is to provide analysis of designed oil extractor with improved, durable groundnut oil expeller for manufacturing by using local sourced materials.

Other specific objectives are:

- To develop a model of machine that will extract oil from groundnut after manufacturing the oil extraction machine, within a minimum time frame.
- To provide structural analysis of designed Groundnut oil extractor for manufacturing which will be affordable for small scale oil miller or domestic users.

III. PROBLEM STATEMENT

Groundnut oil expeller has been developed and constructed by some researchers in different sizes, shapes and materials. In order to assist the small scale oil millers, Domestic groundnut oil expellers need to be analyzed by its design for constructing a Domestic oil extraction machine with locally available materials.

IV. DESIGN

1. Hopper

The hopper is the feed chute with the following dimensions:
High = 200mm
Smaller cone diameter = 78mm and Larger cone diameter =200mm
Material – Mild Steel Plate

2. Cylindrical Barrel

This will fabricate to accommodate the required quantity of raw material. The barrel consist of the following Dimensions:
Length of barrel =398mm
Diameter of barrel =60mm
Diameter of the perforation on barrel = 2mm
Thickness of material =5mm
Material - Cylindrical pipe (mild steel)

3. Expeller Screw

This will fabricate into the following section; crushing or grinding and pressing section of the nut. Dimensionsof the Screw shaft:
Length of the shaft = 500mm
Diameter of shaft = 30mm
Minor diameter of the shaft = 20mm and pitch of the screw shaft =10mm
Material required for expeller screw will take as per the result of analysis in which we found that Steel grade whose yield strength is greater than 281 Mpa use for the Expeller screw.

4. Frame Design

The frame support the machine and is firmly fastened together with bolt and nut to allow easy dismount-ling. The prime mover is a 1hp electric motor of 60 rpm with belt and pulley arrangement. Dimension of the frame
Top =394 x 200mm
Bottom = 540 x 250mm
Height =610mm
Material =1/2 inch angle iron

Bill of Material

S/N	Name of point	Material/Description	Quantity
1	Hopper	Mild steel plate	1
2	Cylindrical Barrel	Mild steel	1
3	Expeller Screw	Structure steel whose yield strength greater than 281 Mpa	1
4	V-Belt	Rubber	1
5	Induction motor	1 hp	1
6	Pulley	2 inch dia.	2

Computer-aided design (CAD) is the use of computer systems (or workstations) to aid in the creation, modification, analysis, or optimization of a design. CAD software is used to increase the productivity of the designer, improve the quality of design, improve communications through documentation, and to create a database for manufacturing. CAD output is often in the form of electronic files for print, machining, or other manufacturing operations. CAD software for mechanical design uses either vector-based graphics to depict the objects of traditional drafting, or may also produce raster graphics showing the overall appearance of designed objects. However, it involves more than just shapes. As in the manual drafting of technical and engineering drawings, the output of CAD must convey information, such as materials, processes, dimensions, and tolerances, according to application-specific conventions.

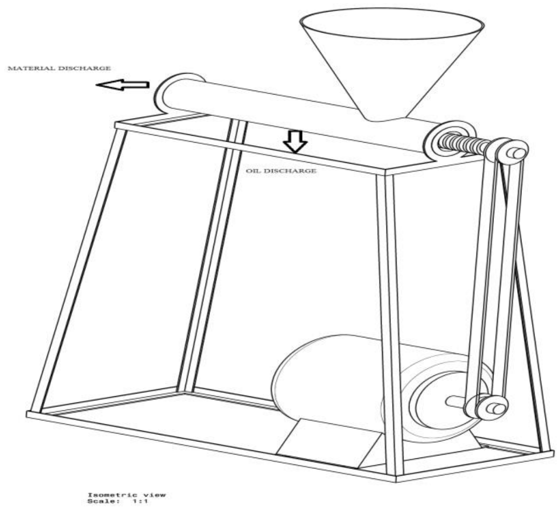


Fig. 1 Schematic diagram of the oil extraction machine

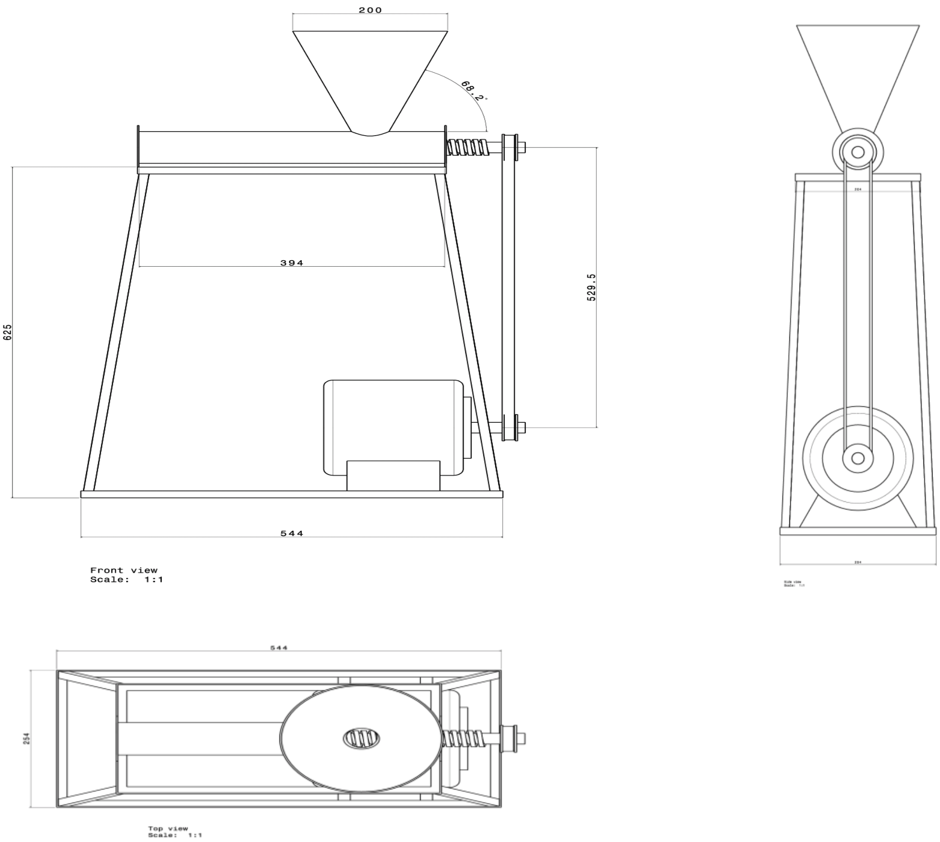


Fig. 2 Structure view of Groundnut oil extraction machine

V. ANALYSIS

The finite element method (FEM), is a numerical method for solving problems of engineering and mathematical physics. Typical problem areas of interest include structural analysis, heat transfer, fluid flow, mass transport, and electromagnetic potential. The analytical solution of these problems generally require the solution to boundary value problems for partial differential equations. The finite element method formulation of the problem results in a system of algebraic equations. The method yields approximate values of the unknowns at discrete number of points over the domain. To solve the problem, it subdivides a large problem into smaller, simpler parts that are called finite elements. The simple equations that model these finite elements are then assembled into a larger system of equations that models the entire problem. FEM then uses variation from the calculus of variations to approximate a solution by minimizing an associated error function.
Studying or analyzing a phenomenon with FEM is often referred to as finite element analysis (FEA).

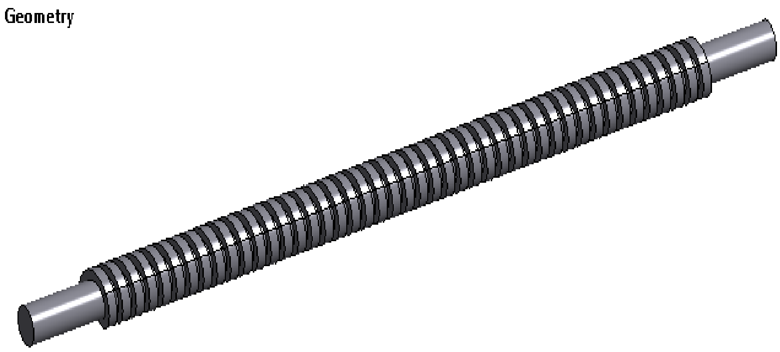


Fig. 3 Geometry of expeller screw

Table 1 Properties of material

Properties of Outline Row 3: Structural Steel

	A	B	C
1	Property	Value	Unit
2	Material Field Variables	Table	
3	Density	7850	kg m^-3
4	Isotropic Secant Coefficient of Thermal Expansion		
5	Coefficient of Thermal Expansion	1.2E-05	C^-1
6	Isotropic Elasticity		
7	Derive from	Young's Modulu...	
8	Young's Modulus	2E+11	Pa
9	Poisson's Ratio	0.3	
10	Bulk Modulus	1.6667E+11	Pa
11	Shear Modulus	7.6923E+10	Pa

Fig. 1 shows Geometry of oil expeller screw which is taken in ANSYS for static structural analysis and Table 2 shows properties of material. Apply second order tetrahedron element mesh which shows in Fig. 4.For providing boundary conditions to the Geometry of oil expeller screw we need torque which is required for crushing by using following formula.

$$P=\frac{2\pi NT}{60} \text{...........1}$$

Where,

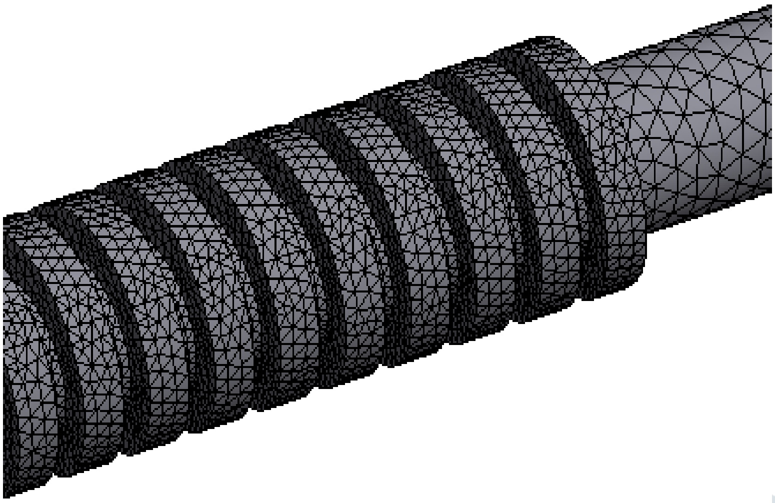
P- Power required in watt (750 w)

N- Average shaft speed (60RPM)

T-Torque = ?

From above equation 1 we get the value of torque

$$T = 119.4 \text{ Nm ....2}$$



Statistics	
Nodes	467999
Elements	308939

Fig. 4 Meshing of expeller screw

Static Structural Analysis is carried out with the given loading conditions in ANSYS. At point A we applied the torque which we have calculated above and point B is fixed shown in fig. 5.

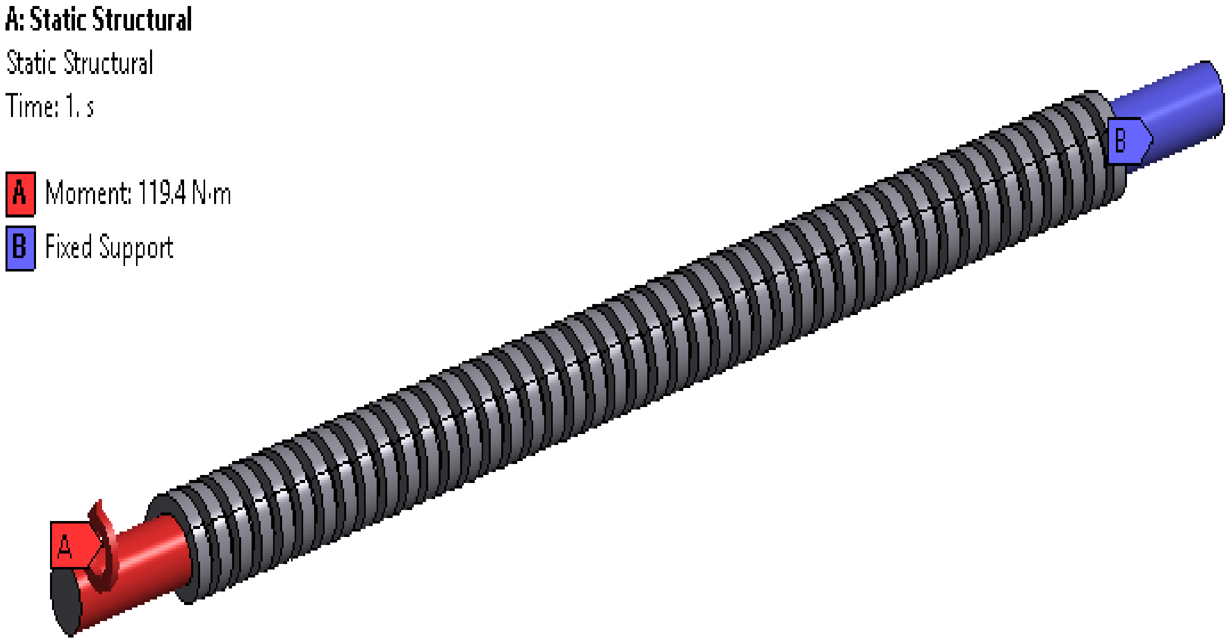


Fig. 5 Boundary condition

The results for Total deformation, equivalent stress and maximum shear stress are plotted as shown in fig. 6, 7 and 8.

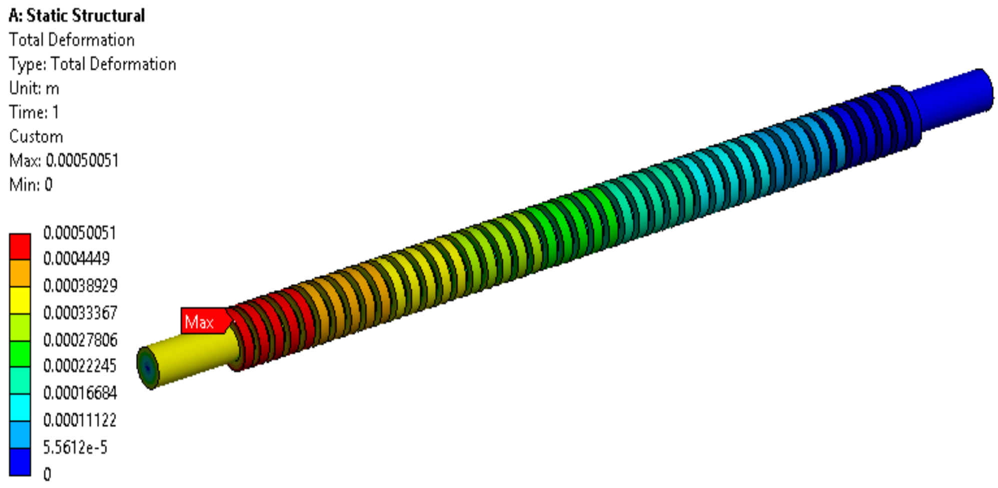


Fig. 6 Total deformation

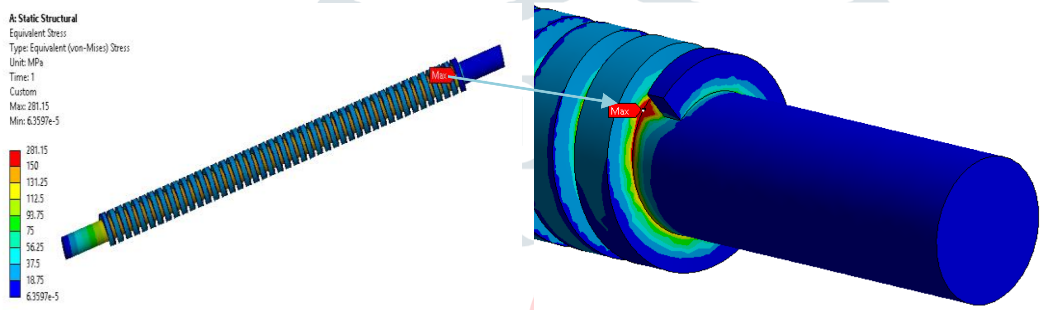


Fig.7 Equivalent stress

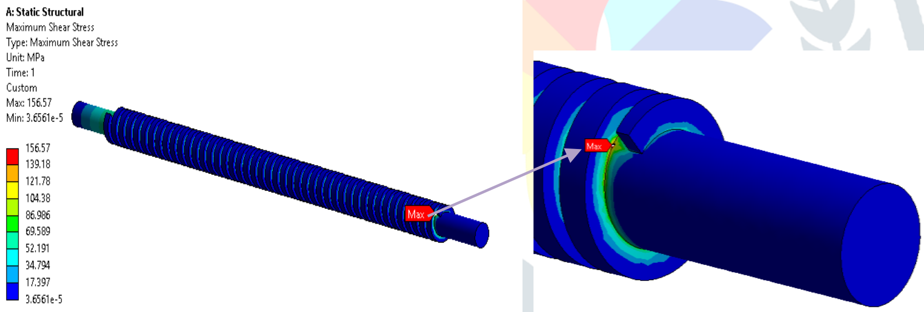
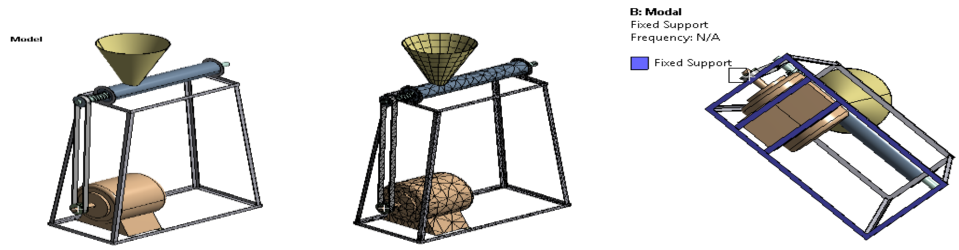


Fig. 8 Maximum shear stress

Vibration Analysis refers to the process of measuring the vibration levels and frequencies of machines, and using that information to determine the “health” of the machine, and its components. Vibration may influence the durability and reliability of machinery systems or structures and cause problems such as damage, abnormal stopping and disaster. Vibration measurement is an important counter measure to prevent these problems. Vibration analysis of the Groundnut oil extraction machine is carried out in ANSYS. Fig. 9 shows the model, meshing and fixed support of the machine and fig.10 shows the Results of vibration analysis.



Model Meshing Fixed Support

Fig. 9 Vibration Analysis

Vibration Analysis_Results

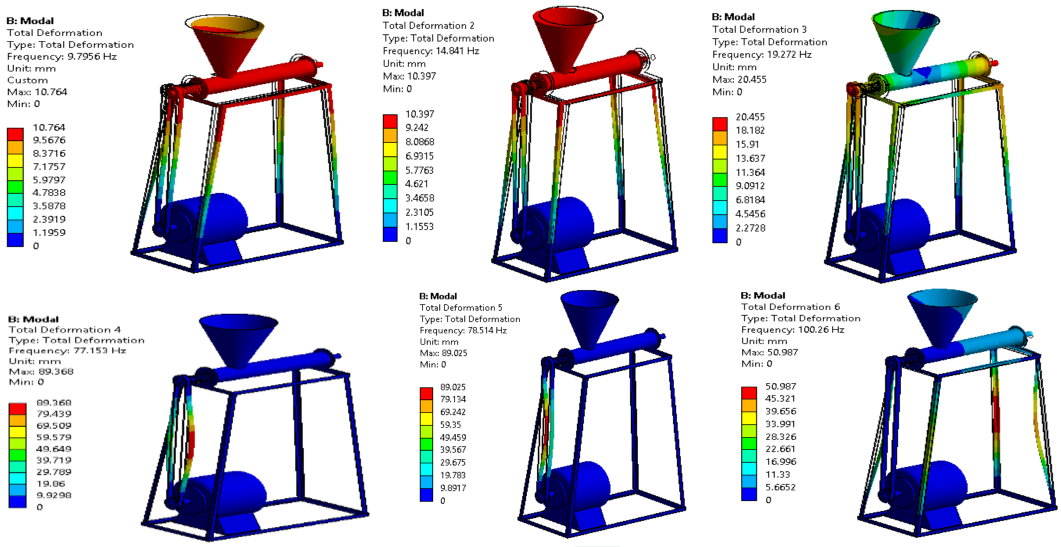


Fig. 10 Vibration Analysis_ Results

All the machine members are subjected different types of loads that may be acting because of energy, toruqe or power transmission, their self weight, frictional resistance, inertia or centrifugal forces and due to temperature gradient. Load may be classified as static or dynamic.

Static load is the load which does not change in magnitude or direction and gradually increases to a steady value e.g. Dead weight of machine elements.Dynamic load is the load which changes in magnitude or direction or both with respect to time. Impact load and shock load are also type of dynamic load. Self weight analysis is also an important aspect.Fig. 12 shows the Geometry, meshing and point A condition provided. Fig. 13 shows results of vibration analysis of Groundnut oil extraction machine in which detection of maximum deformation, equivalent (von mises) stress, maximum principle stress and maximum shear stress is done with ANSYS.

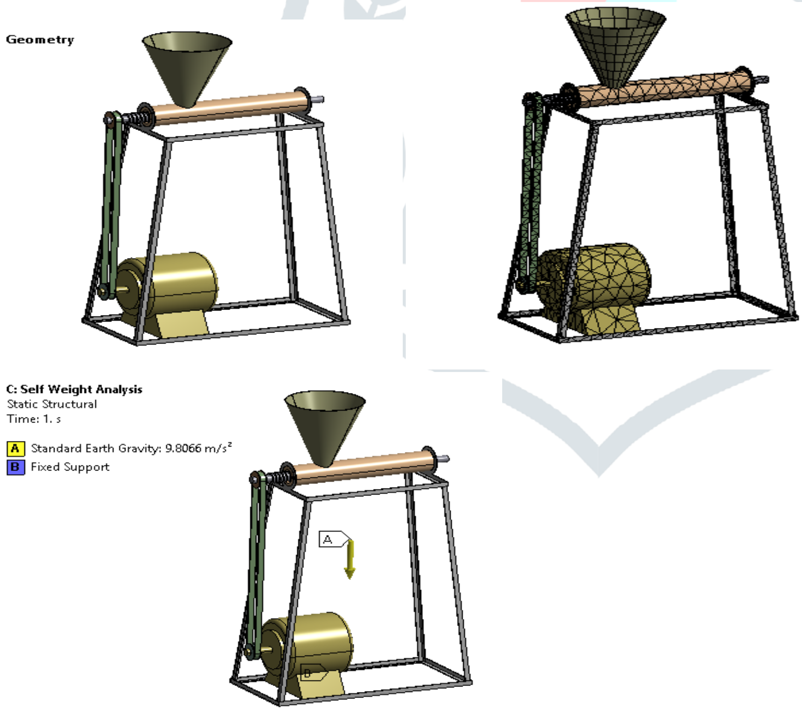


Fig. 12 Self weight analysis

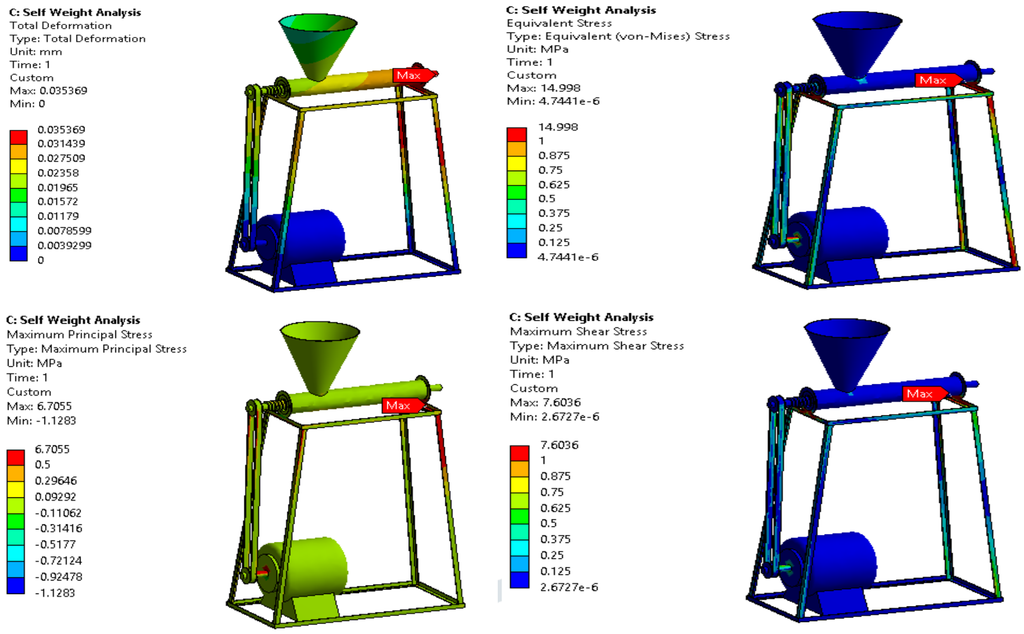


Fig. 13 Self weight Analysis_ Results

VI. CONCLUSION:

1. FEA of Oil Extraction Machine Screw, we conclude that Selection of Steel Grade Will Be Done, Which Will Have Yield Strength Greater Than 281 MPa.
2. Vibration Analysis of Oil Extraction Machine is done and we get resonance frequency.
3. Self weight Analysis of Oil Extracting Machine done. Equivalent stress is below yield limit of Material, hence model is safe for manufacturing.

VII. ACKNOWLEDGMENT

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