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DESIGN AND ANALYSIS OF U-SHAPED RIBBON BLENDER WITH SCREW CONVEYOR

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Abstract: Ribbon blender is the one of the mixing equipment which is largely used in many industrisal application for mixing the material to provide final product with required quality. The performance and efficiency of the blender is most important to achieve the high rate of production. In this highly competitive market where the demand for the product is increasing gradually, it is essential for a manufacturing company to reduce the production time and cost accordingly. In this project several problems regards to ribbon blender is identified and solution is provided with new design to overcome the existing problems. Some of the modification in the ribbon blender will leads to increase the production capacity of plant, quality of mixing and efficiency of the blender with reduction in production time and labour cost.

***Index Terms* – Ribbon blender, blade design , analysis of shaht , performance of blender.**

I. INTRODUCTION

The mixing of various materials is an important operation that concern many industrial fields. It isan important step since it allows combining properties of different powders into single product that has to meet specifications and standards based on homogeneity of mixers. Successful manufacturing of a variety of products is heavily dependent on the efficiency of this process, because the final product quality is inherently dependent on the quality of the obtained mixture. The mixing performance, which is usually characterized by the degree of mixing, is of paramountimportance to the quality of products in industrial processes. Some research investigated the effects of the operating conditions on the particles mixing in cylindrical vertical mixers with bladed impeller, including the fill level, rotational speed and number of impeller blades.

In this ribbon mixer, the mixing vessel was open at the top, and thus the particles were free to move vertically upwards. However, when the particle motion is constrained at the vessel top, circumferential motion of particles becomes dominant as the shaft speed increases, and the curves of mixing index versus shaft revolutions may be affected by the shaft speed, as observed previously in the case of a vertically-shafted cylindrical mixer. Although the use of a low blade speed can reduce stresses on particles and hence particle fractures, it may result in a poor homogeneity when mixing cohesive particles because of the reduction of shear stresses, which are responsible for the diffusing of particles in the mixing .

II. LITERATURE REVIEW:

A.T.Desai, M.G.Kumbhar, R.H.Deokar ,A.M.Mandhare [1] [2018] :*Design And Analysis of Powder Mixing Ribbon Blender - A review* Performances of Dry solid powder mixing with in a twin Ribbon blade blender have been performed in this work in order to characterize mixing behavior in such a mixer of binary mixtures with different cohesionless materials. The effects of fill height and blade rotation speed on mixing homogeneity have been studied. Design considerations had been studied during Analytical Calculations .Analysis of varience is used to determine significance of main effects and their interactions. The residence time is significant by both rotational rate and mixing angle. This paper analyzes the impact of operating conditions and characteristics of a industrial-scale ribbon blender on the blend homogeneity and the mixing rates of commercial dry powder stearate. The loading methods explored are the layering and the off-center spot injection; the benefits of this method is the greater homogeneity of the blends, and the reduction of mixing time.It is also observed that the ratio of the product of median particle size and the bulk density of one ingredient to the other in abinary mixture bears a quadratic correlation to their segregation index.

Musha Halidan [2014] :Particle Mixing Study in Different Mixers In the first part of the study, a vertically-shafted cylindrical mixer was used and the effects of particle size, density and volume fraction on the mixing behaviour of binary mixtures were investigated. The mixture quality showed an improvement if the larger particles are heavier and small ones lighter. With respect to variations in the size and volume fractions, each mixture quality showed a peak value. A correlation was established for predicting the effects of size, density and volume fraction on mixture quality in a wide range of each variable. The correlation predicts a global peak value at an optimum condition of size, density and volume fraction.

III. PROBLEM IDENTIFICATION:

- The blade design for the various blender differs with the type of materials used ,capacity of the blending and rate of production. In the existing blender the blade design is in the form single directional flow of materials in the blender so that , the load on the blender is high at inlet section and low at the exit section .By using the multiple directional flow of materials in the blender we must change the blade design as bidirectional flow to distribute the load evenly through the mixing chamber .
- The block of materials mixing in the blender is occurs due to several conditions such that uneven loading ,excess binders ratio, improper ratio of material , highloading and other cases. In order to clear the block of materials in blender , a emergency doors must be provided to take out the materials suddenly.

IV. METHODOLOGY :

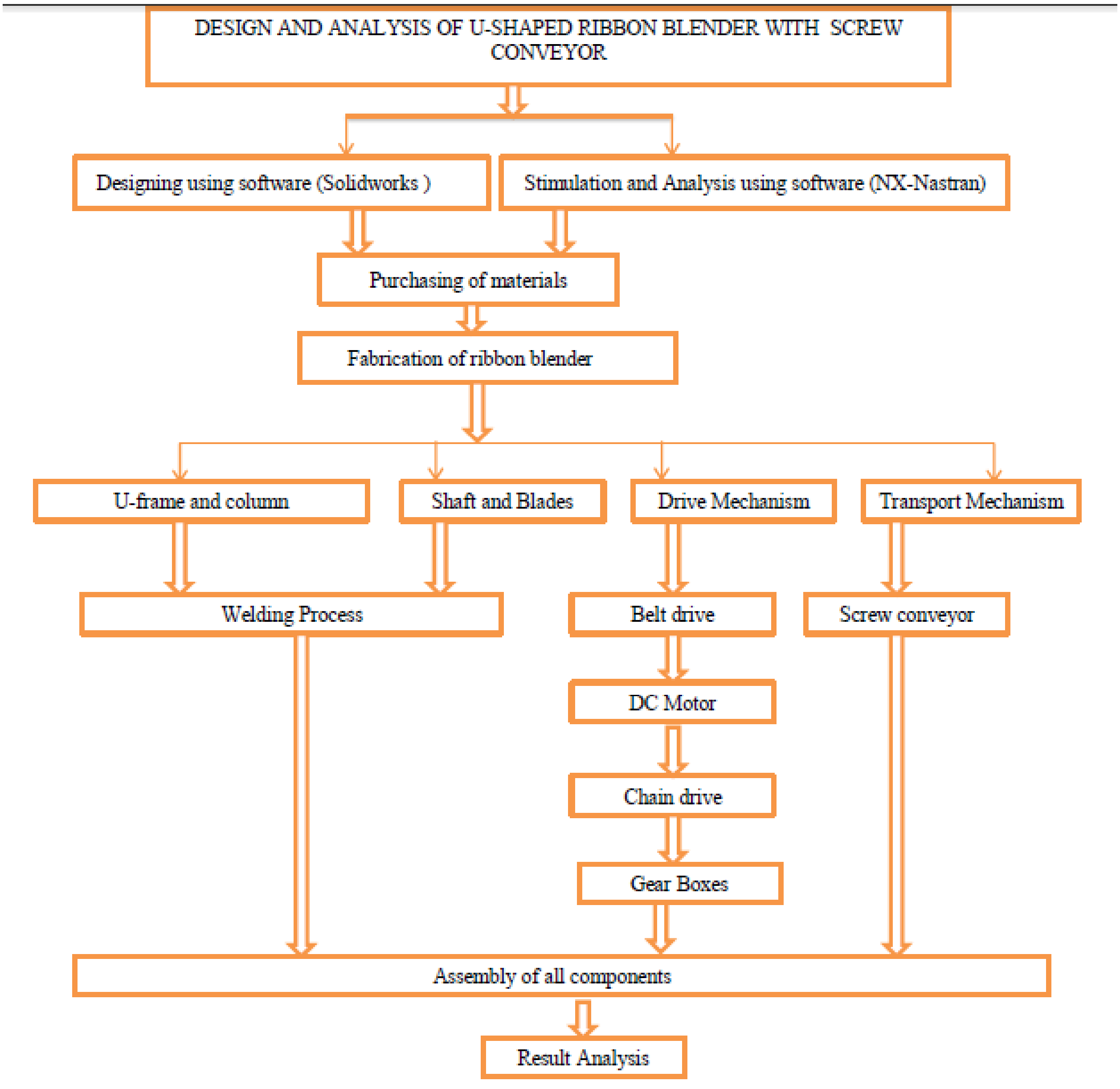

Fig .4.1 .Work plan of ribbon blender

V. DESIGNING THE COMPONENTS OF RIBBON BLENDER:

5.1 U-FRAME AND BASE COLUMN:

The U-frame and base column is designed in the solidworks software based on the requirement capacity and batch production .The following considerations are made while designingthe component .The specifications of the components are:

- Material choosen : Mild steel
- Young's Modulus :210 X10^9 N/m^2
- Poisson ratio: 0.3
- Ductility: 50%AL
- Density: 7850 Kg/m^3
- Capacity of the blender : 2000kg

The dimensions of the components are :

- U-frame thickness: 3 inches
- Diameter of the half circle: 26 inches
- Height of the blender: 76 inches
- Discharge capacity: 150 kg/min
- Base column length: 82 inches
- Base column breadth : 44 inches

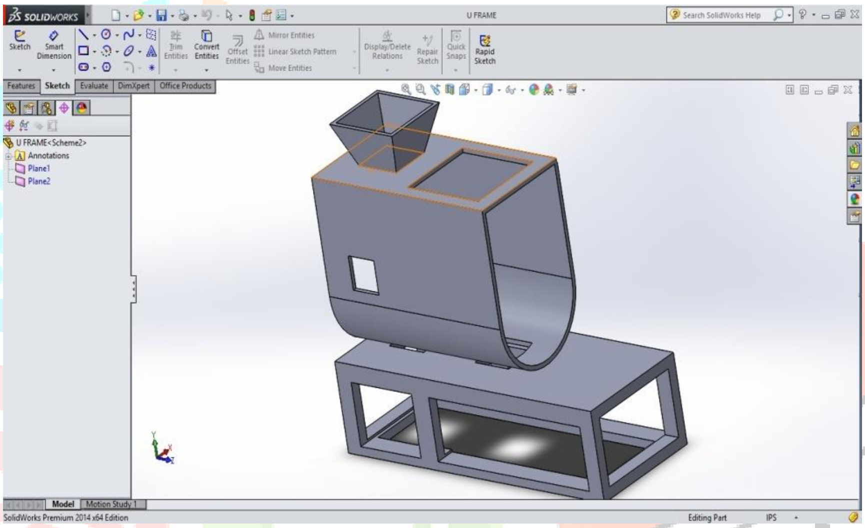

Fig.5.1 Model of U-frame and base column

5.2 SHAFT AND BLADES:

The shaft and blades is designed in the solidworks software based on the requirement capacity and batch production .The following considerations are made while designing the component .The specifications of the components are:

- Shaft diameter : 3 inches
- Lengh of the shaft : 108 inches
- Keyway length : 3 inches
- Blade thichness : 2.5 X 0.5 inches
- Blade diameter : 28 inches
- Pitch of the coil : 24.5 inches
- Helix angle of the blade : 90 degree
- Rod length between blades : 25 inches

The operating speed of the shaft and impeller system must be sufficiently far from the system's natural frequency, often called the *critical speed*, toprevent undamped vibrations. If deflections caused by vibration become sufficiently large, the shaft could bend or break. Although torsional natural frequencies must be examined on very large mixers, in the following discussion we address only the lateral natural frequencies, which affect the design of all mixer shafts.

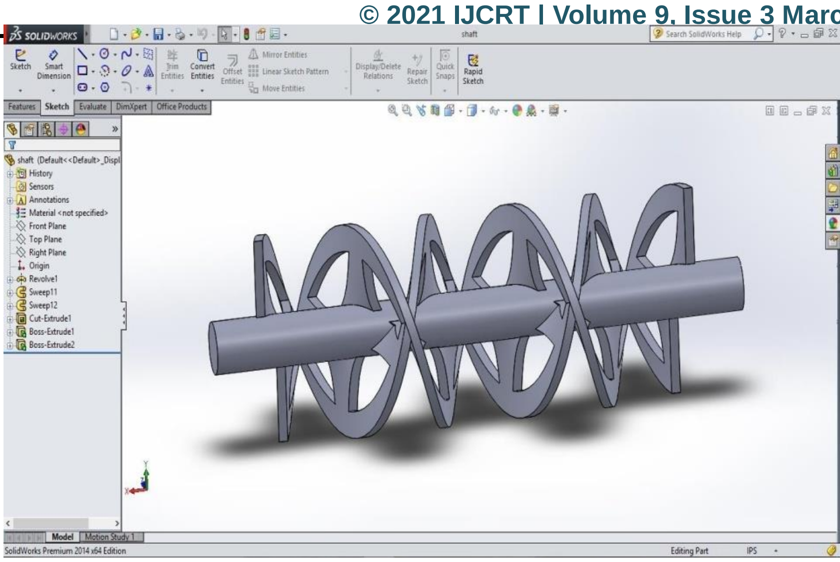

Fig. 5.2 Model of shaft and blades

5.3 SCREW CONVEYOR:

The screw conveyor is one of the oldest methods of conveying materials known to mankind with the original design dating back to more than two thousand years. Since the screw conveyor came into general use a little over a century ago for moving grains, fine coal and other bulk material of the times, it has come to occupy a unique place in a growing area of material handling processing. The specifications and dimensions of the screw conveyor are:

- Inclination angle: 30 to 45 degree
- Length of the screw conveyor: 100 inches
- Screw pitch: 24 inches
- Helix angle :90 degree
- Diameter of the screw: 12 inches
- Diameter of the shaft :4 inches
- Type of covering : circular enclosed type

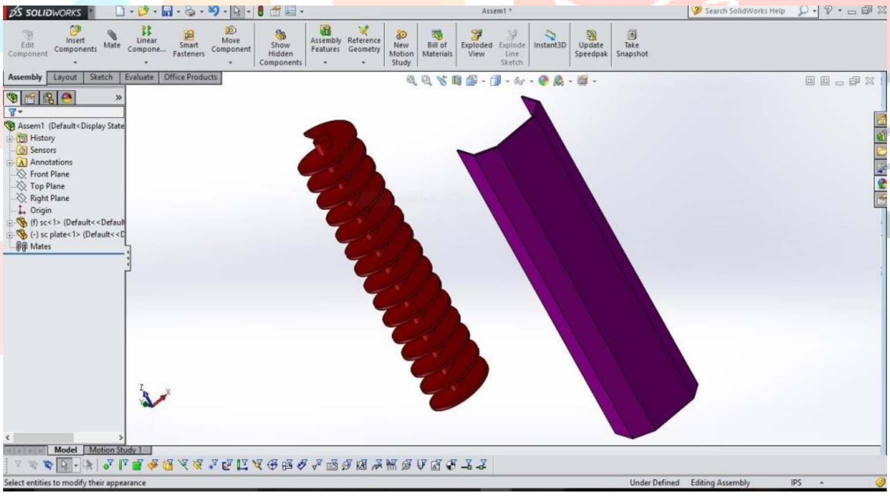

Fig.5.3. Model of screw conveyor

VI. ANALYSIS OF SHAFT AND BLADES:

The shaft and blade analysis is done the NX-Nastran software . The followingresults are obtained in this analysis.

- Structural analysis.
- Thermal analysis.

6.1 NX - NASTRAN:

Nx-Nastran is a finite element (FE) solver for stress, vibration, buckling, structural failure, heat transfer, acoustics and aeroelasticity analyses**.** Manufacturers as well as engineering suppliers in aerospace, automotive, electronics, heavy machinery, medical device, and other industries have relied on NX - Nastran software for their critical engineering computing needs for over 40 years. It allows them to produce safe, reliable and, optimized designs within increasingly shorter design cycles.Nastran is directly compatible to analyze composite structures, with individual ply representation.

6.2 STRUCTURAL ANALYSIS:

MSC Nastran is a multidisciplinary structural analysis application used by engineers to perform static, dynamic, and thermal analysis across the linear and nonlinear domains, complemented with automated structural optimization and award winning embedded fatigue analysis technologies, all enabled by high performance computing.

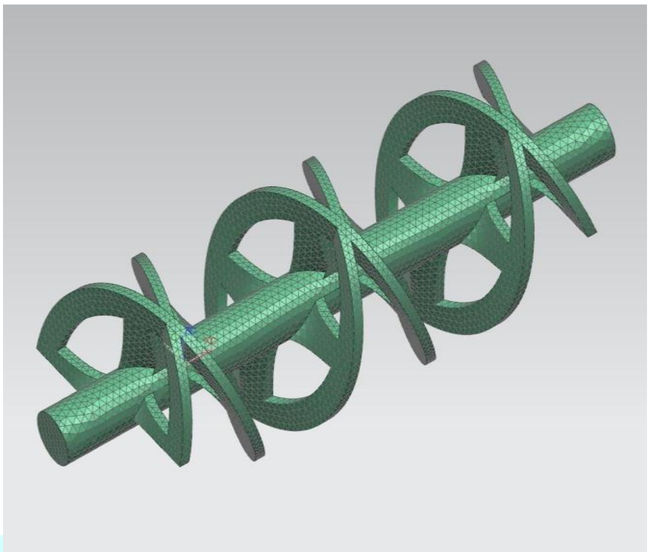

Fig. 6.1 Meshing of shaft

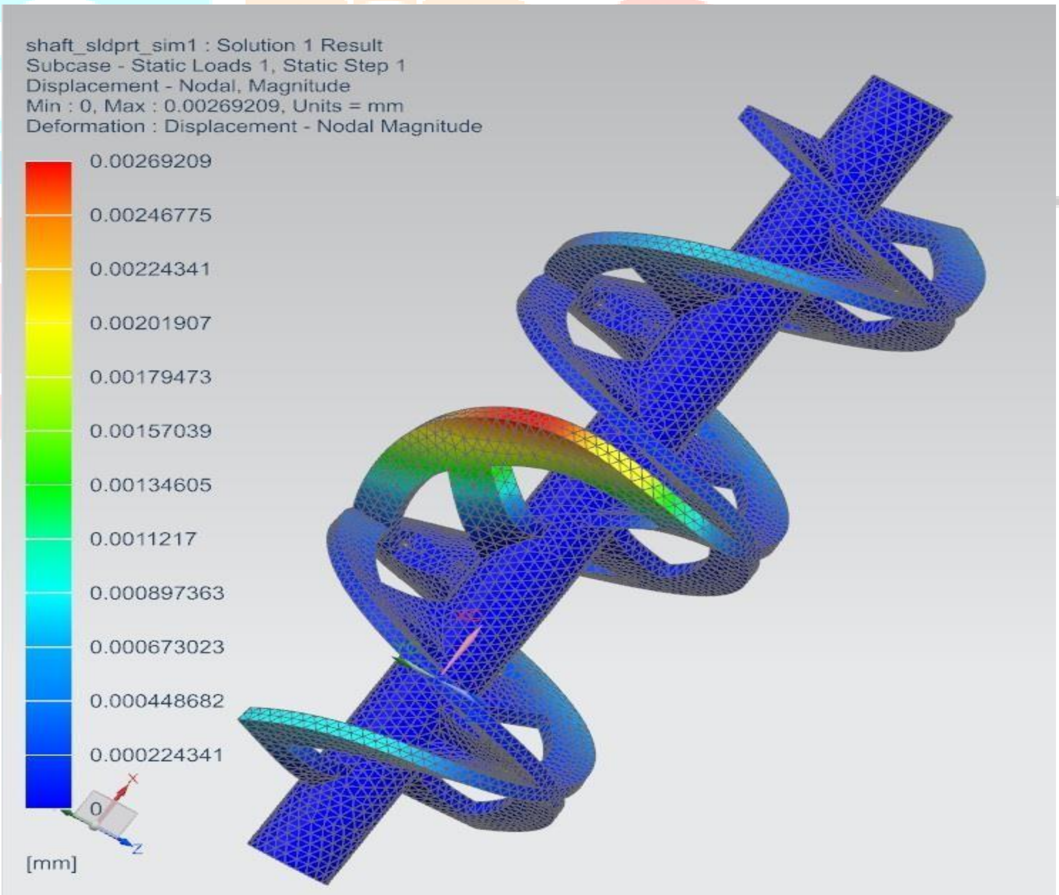

Fig. 6.2. Displacement of nodes

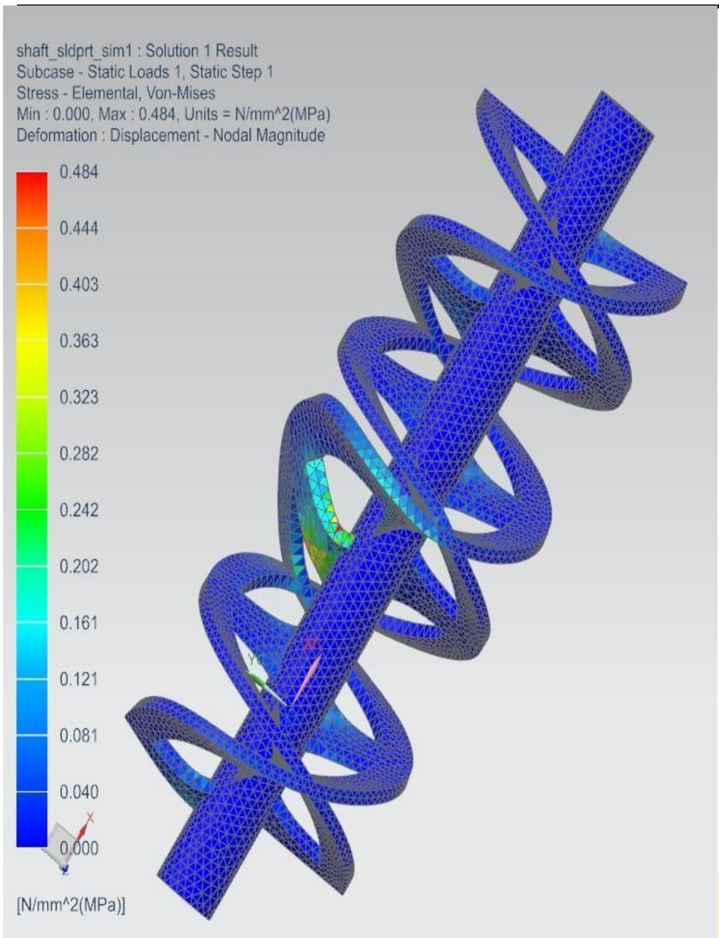

Fig . 6.3 .Stress elemental nodes

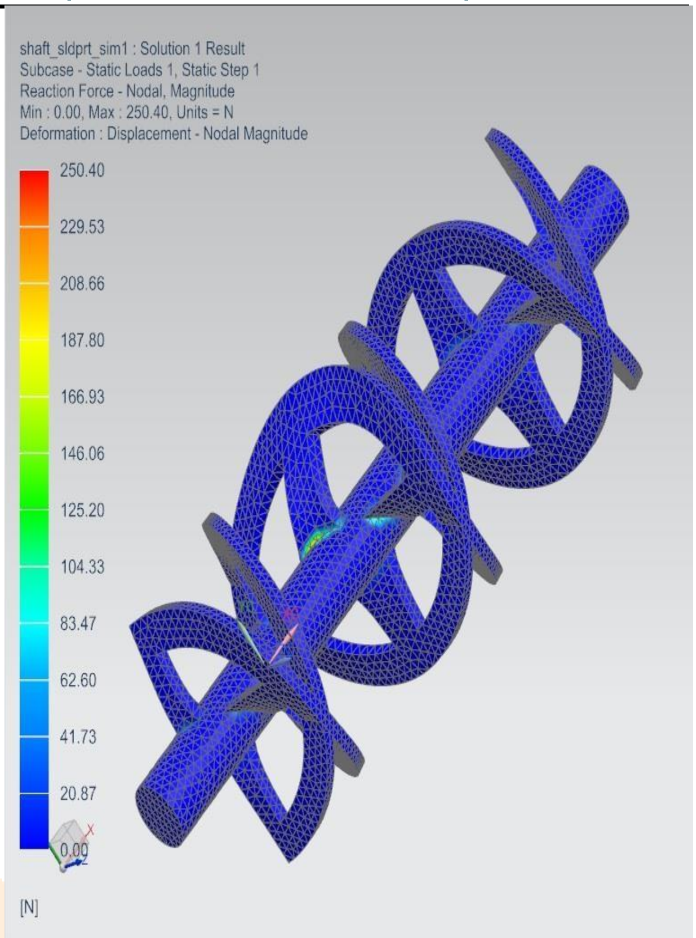

Fig. 6.4. Reaction forces

6.3 THERMAL ANALYSIS:

Thermal-stress or thermal-deflection analysis is driven by strains created in the structure by a temperature load. One of the complexities of this loading is that stresses only develop if the structure is prevented from expanding or contracting or materials with different coefficient of thermal expansion (CTE) are bonded together (e.g., brazed) or mechanical connected (e.g., bolted). One simple way to think about this is to just picture a chunk of aluminum or steel or some homogeneous material (i.e., not a composite) floating in space .As the structure expands or contract due to temperature, the thermally induced strains do not create any stresses but only deflections, as given by this equation:ε=a($Tload{-}Treference$) where the strain (ε) is determined by the change in temperature and the CTE(α)of the material.

Setting up the thermal profile to use as a load case to a structural model can be easy or hard and it is obviously dependent upon the thermal event that is being is being simulation. In our work, we have mapped thermal profiles from static and transient CFD simulations and have done fully coupled electron-beam welding simulations where phase change and residual plastic strains are captured within the work piece. These examples representcomplex thermal analyses that are beyond the scope of this discussion and if your work entails such needs, please contact us and we can provide some guidance. For this discussion, we will stick with simple thermal loads that can be obtained using a fixed temperature delta or from steady-state temperature gradient or using a data surface.

STEPS OF ANALYSIS:

- Set Up the Analysis
- Apply the Loads
- Apply the Constraints
- Run the Analysis
- Post-Process the Results

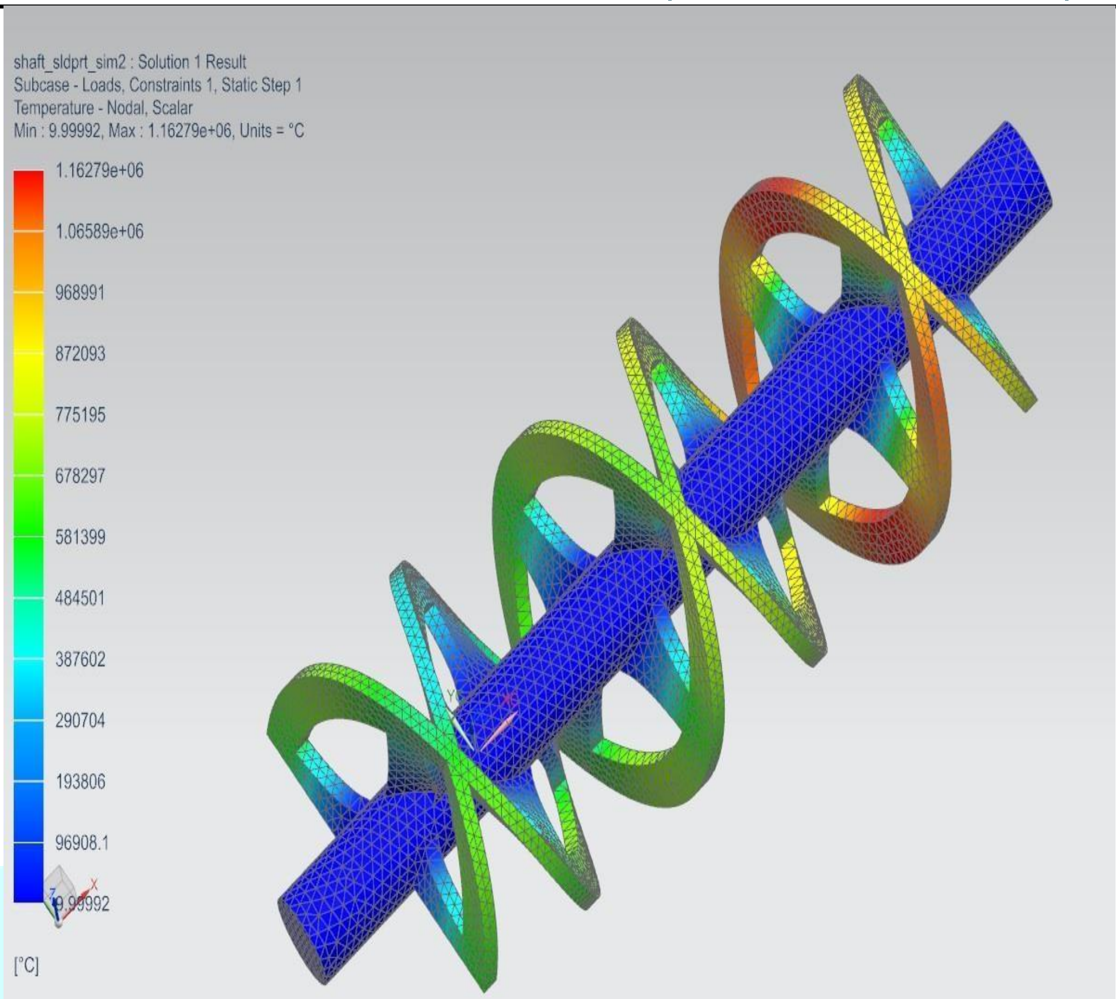

Fig.6.5. Thermal stress analysis

VII . ASSEMBLY OF COMPONENTS AND FABRICATED U-BLENDER :

The below diagram shows the assembly and line sketch of the ribbon blender which is performed in the solidworks software to determine the final fabricated model in the software.

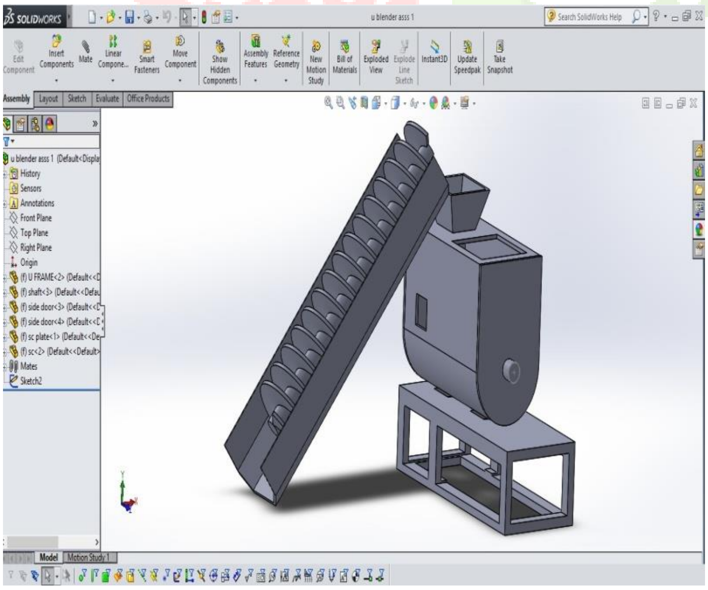

Fig.7.1 .Assembly of ribbon blender

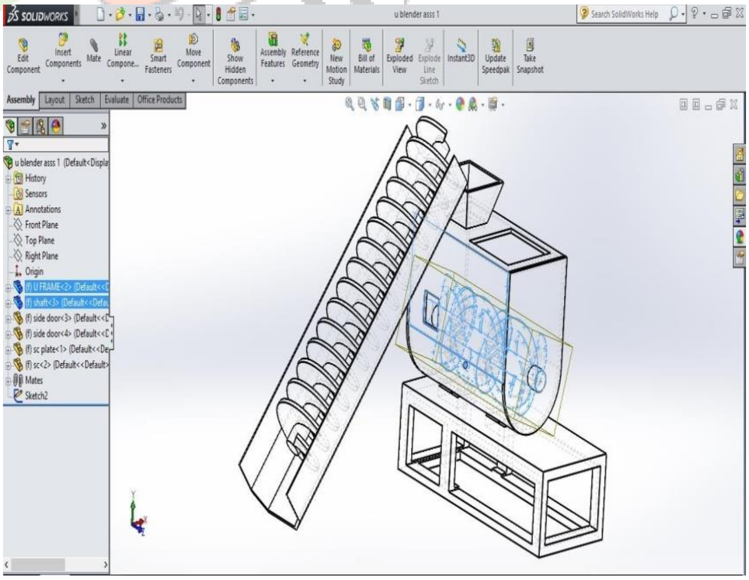

Fig. 7.2 Line sketch of ribbon blender

Fig. 7.3. Fabricated model of ribbon blender

VIII. CONCLUSION:

After a detailed study and analysis of the existing and the newer systems, we implemented the changes in ribbon blender. The implementation to these changes leads to following changes:

- It increases the capacity of the blender from 800kg capacity to 2000kg.
- It increases the rate of production capacity of the plant.
- It improves the mixing rate of the blender because of double helical blade design.
- It reduces the mixing time of materials in the blender.
- Block of material in the blender is easily removed by emergency doors.

IX. FUTURE SCOPE:

Future scope of out project is that it has a higher in industries for mixing of materials for various application. In future, if there is a need to improve the performance of the ribbon blender further, we need not to go for the newer designs. We can achieve further by the simple modification in the equipments.

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