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Design and Analysis of Nut and Bolt Separating Machine

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***Abstract*— The goal of the project is to design a system that can sort nut of different sizes. It would also be able to detect other objects in the process and reject them. The project will be aimed to provide the industry a real machine for direct use in packaging department at very economical price. The components of this nut sorter machines used DC wiper motors, some basic electronic components, Sorter trays. Speed, precision, and design must be at their highest level to succeed. A nut's size is used to sort nuts in this sorter. It is dispensed into the appropriate container based on its size. Structural analysis and model analysis is done for the sorter machine. Equivalent stresses, total deformation and factor of safety is checked. Design is safe.**

Keywords— FEA, sorter machine, static, nut, bolt.

I. INTRODUCTION

The need of Automation in every Industry has become very important. Automation is there from long time in industries but now days industries are not only maintaining quality but also reducing cost of production. Fastener industries produces a vast variety of jobs with different physical or chemical properties and also having small variation in size in this case the need of creating affordable and easy to use equipment's is essential. We can see a huge variety in nut as they have various sizes according to diameter of the hole and if they are mixed then separating them is very difficult job. Thus in this case to provide automation we observed that with change in diameter the height of nut also changes and this can be used to detect the dimensional variation by using very simple sorter tray mechanism in accordance to this idea we designed the nut separation machine.

Assembling industries are facing problems related to material handling of various parts which are difficult to sort manually and due to this problem we were able to study and design model of nut separating machine. Automation is necessary in sorting fasteners because it is very time consuming if done manually. Fasteners are of various sizes and are also used in almost all mechanical industries. they have a close dimensional variation hence they ae easy to mix and if they are mixed it is very difficult job to separate them.

For reducing the various issues in mechanical industries by using automation. To provide a better equipment to industries which are improving material handling systems and reducing human effort. To discover the problems faced by the manufacturing and packaging industries and solving them. Providing solutions to the industries which will remain effective in future also. The automatic sorting machine using conveyor belt is basically useful for sorting

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the products in the industry specifically large scale industries where mass production is carried out. The machine also reduces the efforts of the workers by reducing the time spent for material handling. The application area of this machine is very wide in industries where automation is built [1].

By reading above paper and considering all the important points, we came to know that, Sensors are used for sorting purpose of the nuts [2]. But in our case we are using motor to provide the motion and a square shaped tray with various sizes of holes built in it for sorting purpose. The main purpose of using motor only is to lift the motor compared to sensor is long. Whereas a complex programmed is needed to run the machine in above paper. Here only ON & OFF switch mechanism & simple function is used [3].

Due to the large amount of tomatoes handled and the fragile nature of the fruit, sorting tomatoes has been a problem for both farmers and merchants. Webcams and image processing techniques were used to build a low-cost machine vision system for fault identification and sorting of tomatoes [4]. Beim sorting of agricultural goods using machine vision, it takes a lot of work and the right approaches to tell the difference between size and shape. These three characteristics were retrieved by the image processing algorithms and used to make the sorting choice. [5].

Tomato Sorting Machines sort tomatoes based on their size. Agriculture can benefit from this sorting equipment. It is utilised in agriculture and the food industry. According on their size (Small, Medium and Large), TSM will classify the tomatoes into three categories. TSM is working on belt and pulley arrangement, which is a complex task. With the aid of this document, we were able settle on the materials for our project. Shaft, frame and bearing all operate in a similar way. Mechanically, shafts are utilised to transmit torque and can withstand longitudinal loads. In proposed design, pulley is clamped on the shaft material of shaft C-20, yield strength 261MPa [6].

II. Analytical Design

A digital mock-up (DMU) is a model that is built according to the standard parts available in the market and their measurements. It is used to evaluate optimal package use. All components must be perfectly positioned for production-ready development, including the capacity to accommodate components in terms of geometry and set them into place. To ensure a seamless start to the manufacturing. With CATIA V5 software, this is the finest way to design any machine.

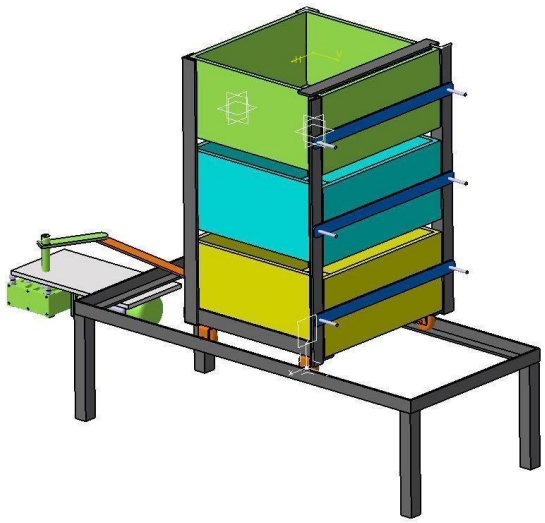

Figure 1. 3D model of sorting machine

A. Weight calculations

To select dc motor, we need to calculate total weight which need to slide from motor on frame,

Factor considered for weight

1. Tray weight
2. Nut, bolts weight
3. Frame weight

1. Tray weight

Tray weight from cad model = 1.3 kg x 3 Tray

= 3.9 kg = 4kg round off (1)

Assume 15 nuts,

M6 × 15 nuts = 2.50gm × 15 = 37.5 grams

M8 × 15 nuts =5.1 gm ×15 = 76.5 grams

M10 × 15 nuts = 11.6 gm ×15 = 174 grams

Overall Weight of Nuts,

Total weight = 37.5 +76.5+174

Total weight of nut = 288 grams

Total weight of Bolts

(15 × M6) + (15 × M8) + (15 × M10) bolts

= 4 kg weight

Frame weight;

From cad by assign mild steel material density to frame = 7.8 kg.

Overall Weight,

Tray = 4kg round off. (2)

Total weight of nut = 288 grams (3)

Total weight of bolts= 4 kg weight (4)

Frame = 7.8 kg (5)

Overall Weight = A +B+C+D = 16 Kg

Consider factor of safety and other factors = 16 + 4 kg extra wright 20 kg,

Total weight with factor of safety = 20 kg

Power = Force × Velocity

Here, assuming we are lifting the weight at a constant speed, the force applied by the

motor is equal and opposite to the force applied by gravity, which is

F=m g =20kg (10m/s^2) = 200N

Velocity V= 1m/60Sv =1m/60s

Power P=F V =200N (1m/60s) =3.33watt

From market we got below dc motor suitable for our project with 12V power.

• Speed in rpm = 600

• Number of poles = 4

• Shaft Length = 30 mm

• Motor Diameter = 28.5 mm

• Gearbox Diameter = 37mm

Now for calculating Working Frequency we use the formula,

N = 120f /P

Where, N= Rpm and P = No. of Poles.

600 = 120f/4

f = 20 Hz

Hence our working frequency is 20 Hz.

IV. FEA ANALYSIS

Finite Element Analysis or FEA is the simulation of a physical phenomenon using a numerical mathematic technique referred to as the Finite Element Method, or FEM. This process is at the core of mechanical engineering, as well as a variety of other disciplines. It also is one of the key principles used in the development of simulation software. Engineers can use these FEM to reduce the number of physical prototypes and run virtual experiments to optimize their designs.

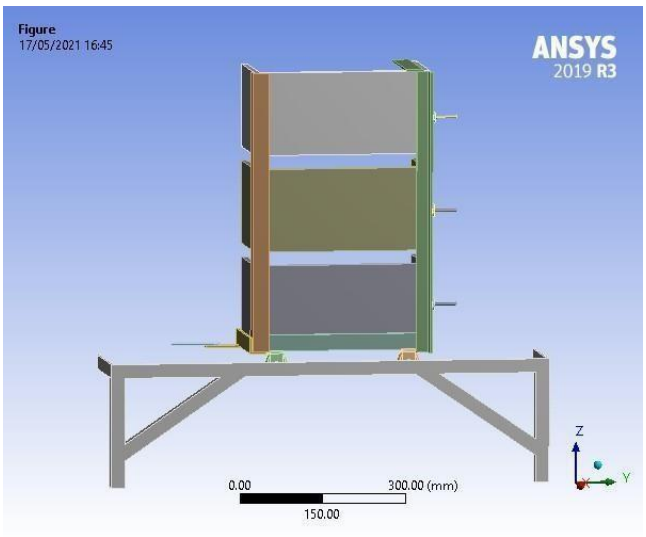

Figure 2. Geometry

Meshing is the process in which the continuous geometric space of an object is broken down into thousands or more of shapes to properly define the physical shape of the object. The more detailed a mesh is, the more accurate the 3D CAD model will be, allowing for high fidelity simulations.

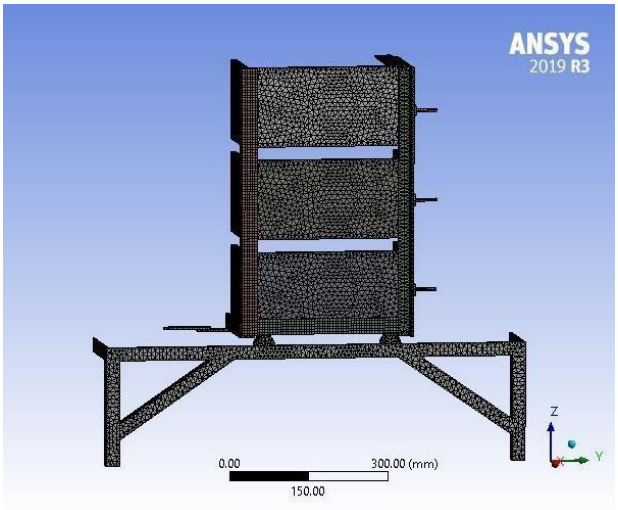

Fig. 3 Meshing

Details of meshing used

• Element Size: 5.0 mm

• Minimum Edge Length: 0.41406 mm

• Nodes: 159258

• Elements: 73740

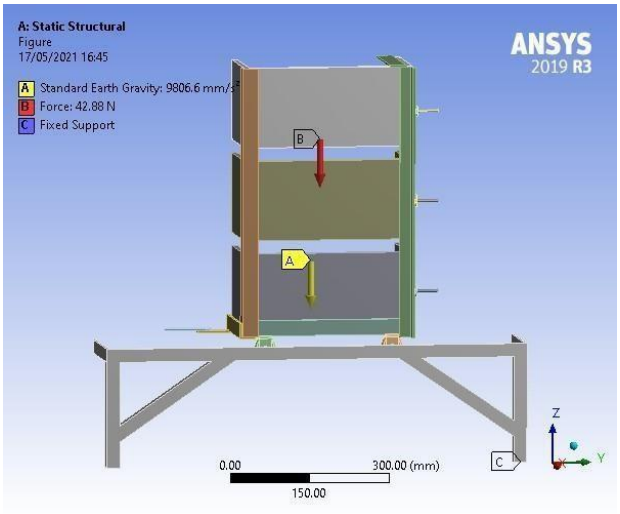

Figure 4. load apply

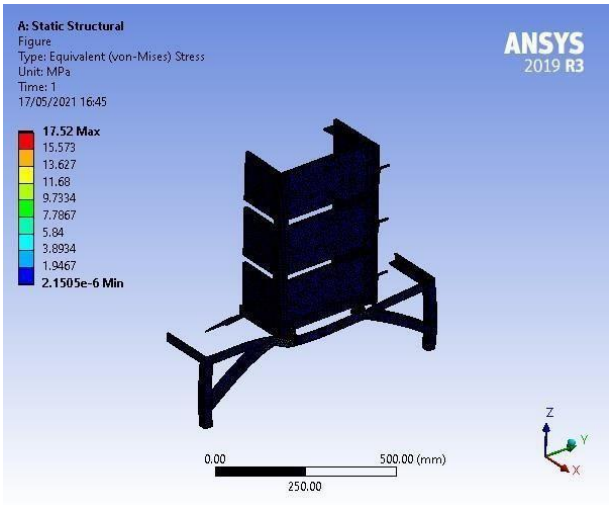

Figure 5. Equivalent Stress

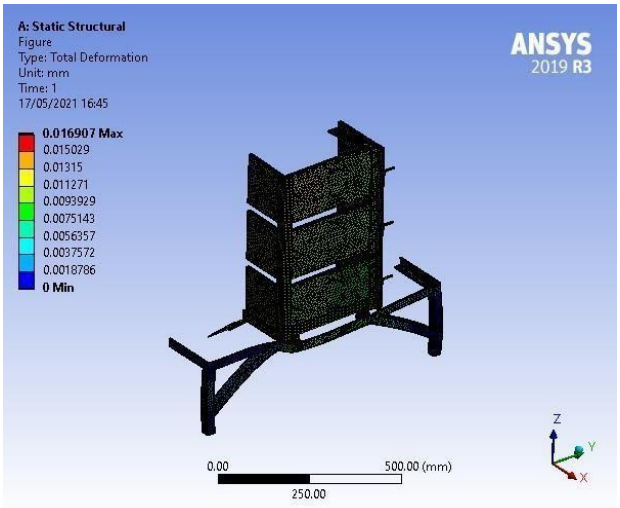

Figure 6. Total deformation

TABLE1

EQUIVALENT STRESS

Minimum Equivalent (von-Mises) Stress	2.1505e-006 MPa
Maximum Equivalent (von-Mises) Stress	17.52 MPa
Average Equivalent (von-Mises) Stress	0.25887 MPa

TABLE II

TOTAL DEFORMATION

Minimum deformation	0.0 mm
Maximum deformation	1.6907e-002 mm
Average deformation	9.5699e-003 mm

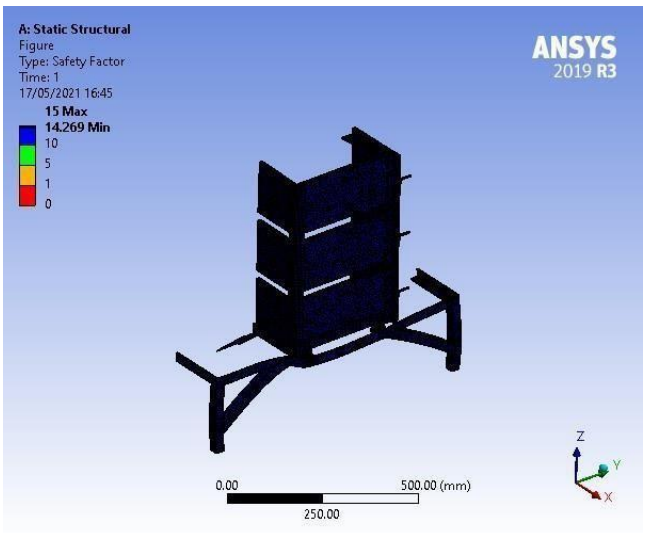

Figure 7. Factor of safety

V. CONCLUSION

In addition, the machine's sorting speed is faster than that of a human operator, resulting in a significant reduction in the cost of inventory. When it comes to packaging, the industry where it is made is where it belongs. Used as a large-scale piece of machine hardware (such a machine's construction). Nuts of close dimension are utilized in construction of structures and towers. Structural analysis is done for the sorter machine. Equivalent stresses, total deformation and factor of safety is checked. Design is safe.

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