HORMONIC AND VIBRANIUM ANALYSIS FOR A SILO SURFACE CLEANING ROBOT

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Abstract: *A silo is a cylinder surmounted by a hemisphere. A suspended robot is used for surface cleaning in silos. In operation, the cleaning tool removes the buildup materials from the inside silo surface by blowing a pressurized air on a stripe while rotating around the silo vertical axis, and the robot fully covers the inner surface of the silo through successive crawling movements of its two platforms. During these two essential process (cleaning and crawling), the system is subjected to different types of loads. In this thesis, finite element analysis is performed on the silo surface robot by applying different loads. 3D model of the robot is done in Creo 2.0. Static, Modal and Random Vibration analysis is done to determine displacements, stresses, frequencies. The analysis is conducted by varying the materials Steel and Aluminum alloy of the robot arm and at different loads. Analysis is done in Ansys.*

Keywords: Robot, 3D Model, Random Vibration Analysis

1. INTRODUCTION TO ROBOTICS

A robotic is a system—mainly one programmable through a computer— capable of wearing out a complex collection of movements mechanically. Robots may be guided by an external manage tool or the manage can be embedded inside. Robots can be built at the lines of human form, but maximum robots are machines designed to carry out a undertaking with no regard to their aesthetics.

Robots may be self sustaining or semi-autonomous and range from humanoids consisting of Honda's superior Step in innovative Mobility (ASIMO) and TOSY's TOSY Ping Pong gambling robotic (TOPIO) to industrial robots, clinical working robots, patient help robots, canine therapy robots, together programmed swarm robots, UAV drones together with popular Atomics MQ-1 Predator, or even microscopic nano robots. by using mimicking a practical appearance or automating actions, a robot may convey a experience of intelligence or concept of its own. Autonomous things are expected to proliferate in the coming decade, with home robotics and the autonomous automobile as a number of the principle drivers.

1.1Applications of robots

1. Arc Welding
2. Spot Welding
3. materials dealing
4. device Tending
5. painting
6. choosing, Packing and Palletizing
7. meeting
8. Mechanical cutting, Grinding, Deburring and sprucing
9. Gluing, Adhesive Sealing and Spraying materials
10. Other tactics

2. SILO FLOOR ROBOTIC

Cleaning a silo is a tedious work and really risky activity for human beings due to many factors which includes: unsafe oxygen level, engulfment, biological, mechanical, electric, and atmospheric dangers. The necessities of the ecu norms associated with hygiene and food best mean that silos ought to be wiped clean extra frequently and obligatory after a silo is absolutely emptied. Therefore, there's an accelerated societal need of silo cleaning and a natural necessity of replacing human beings through robot manipulators in executing this risky and perilous process. In a preceding observe an in depth survey of current technologies and answers for cleaning in big confined areas indicates that to easy the whole extent of the silo, solutions as hydraulic and pneumatic whips and augers, cardox tubes, acoustic purifier are very powerful to take away the build up substances. These tools operate and interact directly with the material this is in the confined area if you want to launch the jams and allow emptying the gap. The used techniques are characterised by low precision, tough layout, careless about contamination, excessive tolerance towards remaining fabric staying on the walls, consequently they don't fit the goal of achieving fine wiped clean interior floor.

Cleaning and sanitation of the interior surface calls for every other technique, particularly the cleaning tool(s) need to interact with the floor handiest, however not to function inside the huge volume of the confined area. whilst speak me about meals silos, special focus isn't most effective at doing away with the cloth from the quantity, but at eliminating all small portions and particles from the silo floor. The implication is that an answer based on robot manipulator has to engage with the silo surface. Due to the typically big measurement of a silo, the amount of feasible technical preparations isn't massive. Maximum of them are associated with the above noted solutions, and 3 agencies can be summarized:

They use grippers to seize firmly structural element to be had on the surface, or various varieties of adhesion, consisting of magnetic adhesion used to engage with ferromagnetic floor or such elements on the surface, or vacuum adhesion for non tough and comparatively easy surfaces. Huge silo are commonly fabricated from concrete and there is no ferromagnetic surface or some other elements to apply magnetic adhesion or grippers. Vacuum adhesion is easy to implement, but normally the floor of meals silos is included by a layer of particles and seeds, which strongly deteriorates the adhesion situations. Our evaluation summarizes the following principal conclusions for designing a surface cleaning robot:

• the majority of the present cleansing gadget is built for cleansing the complete silo quantity, but now not for cleansing and sanitation of the interior surface.

• Most robots are used for inspection and preservation obligations where the payload is too small.

• Most current cleaning robots are utilized in small and metal confined area.

3. THE SIRO IDEA

Moving the cleaning equipment inside the silo and accomplishing each point of its interior floor is the giant characteristic for SIRO. A classical solution to acquire this capability is to use two actions: one translational movement of the tools along the silo's vertical axis and rotation around that axis. The implementation of every motion isn't a simple undertaking itself due to the large dimension of the gap. Vertical linear movement on a top of 20 – 30 m implies using suspension precept, wherein the gravity can be applied correctly. As any mountain climbing robot cannot live firmly at the silo wall because of extraordinarily bad situations for adhesion, the most effective viable manner is to droop the robot bearing the cleansing gear equidistantly to the wall.

The vertical robot position is changed with the aid of varying the duration of the suspension metal cable.

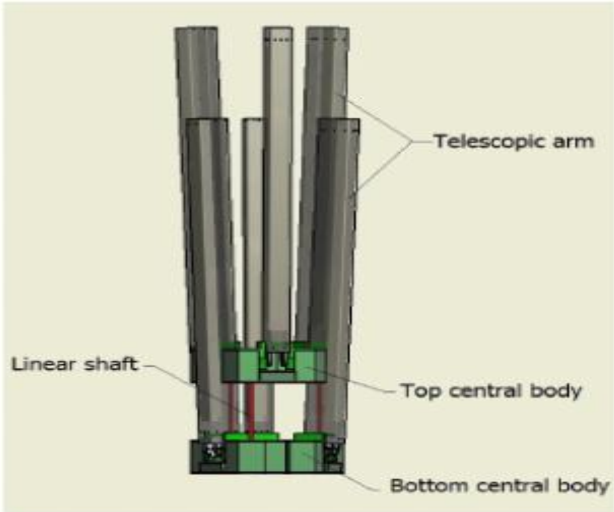

Fig:1- The platforms and the arms in preliminary pose

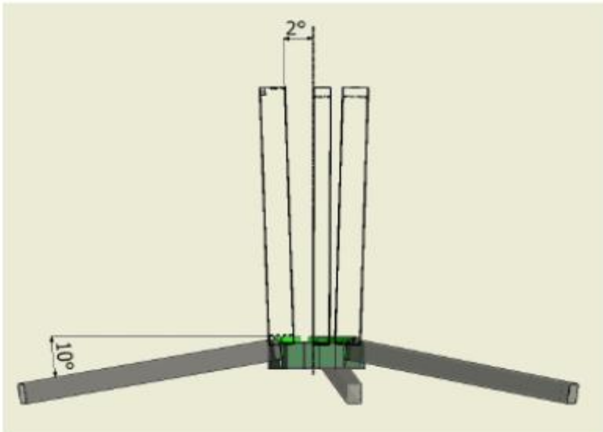

Fig2:- The hands of one platform in opened pose (retracted)

The important frame has a hexagonal prism shape and the three palms are linked to its lateral floor by using pivot joint with an angular shift of a hundred and twenty◦ among each other. 3 linear bearings are fixed inside the significant body to understand the linear motion among the 2 platforms through 3 loose shifting linear shafts. The two systems are placed one over different with angular shift of 60◦ across the vertical axis. The suspension cable is hooked up to the top platform and the crawling cable is connected to the bottom one. When suspension cable is fixed, one may additionally pull/release the crawling cable for moving the lowest platform up/down.

The telescopic arm with 1500 mm duration in re traced shape includes three segments (Fig. three) of lengths 1500 mm, 1400 mm, 1300 mm can attain in make bigger shape a duration of 2400 mm. The first section of the telescopic arm incorporates the driving motor with ball screw mechanism that transfers the movement to next segments with the aid of a system of pulleys and ropes. While section 2 begins to increase, cable 1nand pulley 1 force phase three to extend concurrently with phase 2. Whilst phase 2 retracts, pulley 2 and cable 2 retracts phase 3 at the equal time, so section three always extends/retracts with phase 2.

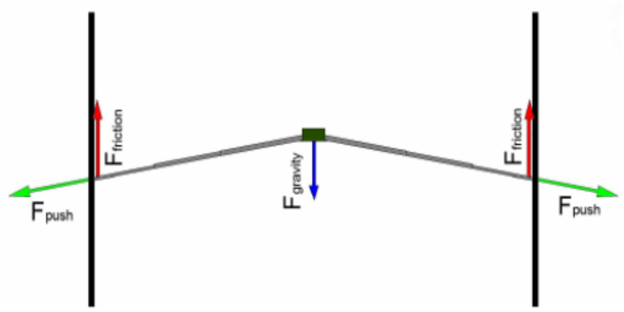

Fig3:- Simplified forces diagram for one platform

3.1 Holding a position

To maintain a vertical role, the hands of as a minimum one of the platforms need to make bigger till they get touch to the interior silo floor. Because of the same extension pace, the arms must have the identical extended lengths, therefore the robot will be nearly focused inside the cylindrical silo. The suspension cable neutralizes the gravity force F gravity caused by the robotics' mass. While the fingers attain the indoors floor, the suspension cable is slightly released, consequently F gravity is no extra compensated, hence it reasons multiplied touch force. The friction pressure between the hands and the vertical surface have to be bigger than the gravity pressure relying at the mass of the robot, F friction > F gravity. The appropriate friction pressure is generated by way of a pushing pressure F push produced by using the ball screw mechanisms inside the fingers, and by means of increasing the friction coefficient between the arm and the wall. Furthermore the arch form fashioned with the aid of the robot palms configuration reinforces the stability as well, in which the critical frame of the platform plays the role of a keystone in the arch. At each second as a minimum one platform ought to be able to maintain robotics' weight and prevent sliding. At some point of the cleaning manner the robot isn't always moving, i.e. the palms of both systems are in touch to the silo wall, hence the stableness of the robots is even extra enhanced. When the robotic is to transport up/down, the palms of most effective one platform are in contact. If none of the palms is in touch, the robotic systems stay at the same peak, as the suspension and crawling cables provide the help.

3.2 Vertical movement

The motion inside the silo area is finished with the aid of a vertical crawling. The step of this crawling is decided through the space among the 2 structures, which depends at the cleaning location that the cleaning equipment ought to test. The crawling is executed with the aid of small sequential retracting/increasing of the platform fingers followed by sequential pull/release of the suspension and crawling cables

4. INTRODUCTION TO CAD

Throughout the history of our industrial society, many inventions have been patented and total new applied sciences have evolved. Perhaps the single improvement that has impacted manufacturing extra quickly and considerably than any preceding technology is the digital computer. Computers are being used more and more for each sketch and detailing of engineering aspects in the drawing office. Computer-aided design (CAD) is described as the software of computers and portraits Software to useful resource or enhance the product layout from conceptualization to documentation. CAD is most commonly related with the use of an interactive laptop pix system, referred to as a CAD system. Computer-aided format systems are powerful tools and in the mechanical layout and geometric modelling of products and components.

4.1 Introduction to creo 2.0

Creo, PTC's parametric, integrated **3D CAD/CAM/CAE solution**, is used by discrete manufacturers for mechanical engineering, design and manufacturing.

Created via Dr. Samuel P. Geisberg in the mid-1980s, Creo was once the industry's first profitable parametric, 3D CAD modeling system. The parametric modeling strategy makes use of parameters, dimensions, features, and relationships to seize supposed product behavior and create a recipe which allows layout automation and the optimization of design and product improvement processes.

This effective and wealthy layout approach is used via companies whose product strategy is family-based or platform-driven, the place a prescriptive sketch method is fundamental to the success of the diagram process via embedding engineering constraints and relationships to shortly optimize the design, or the place the resulting geometry can also be complex or based upon equations. Creo gives a complete set of design, analysis and manufacturing abilities on one, integral, scalable platform. These capabilities, encompass Solid Modeling, Surfacing, Rendering, Data Interoperability, Routed Systems Design, Simulation, Tolerance Analysis, and two NC and Tooling Design.

5. INTRODUCTION TO ANSYS

ANSYS is general-purpose finite element analysis (FEA) software package. Finite Element Analysis is a numerical method of deconstructing a complex system into very small pieces (of user-designated size) called elements. The software implements equations that govern the behaviour of these elements and solves them all; creating a comprehensive explanation of how the system acts as a whole. These results then can be presented in tabulated, or graphical forms. This type of analysis is typically used for the design and optimization of a system far too complex to analyze by hand. Systems that may fit into this category are too complex due to their geometry, scale, or governing equations.

ANSYS is the standard FEA teaching tool within the Mechanical Engineering Department at many colleges. ANSYS is also used in Civil and Electrical Engineering, as well as the Physics and Chemistry departments.

ANSYS provides a cost-effective way to explore the performance of products or processes in a virtual environment. This type of product development is termed virtual prototyping.

6. MODELLING OF THE SILO SURFACE ROBOT IN CREO 2.0

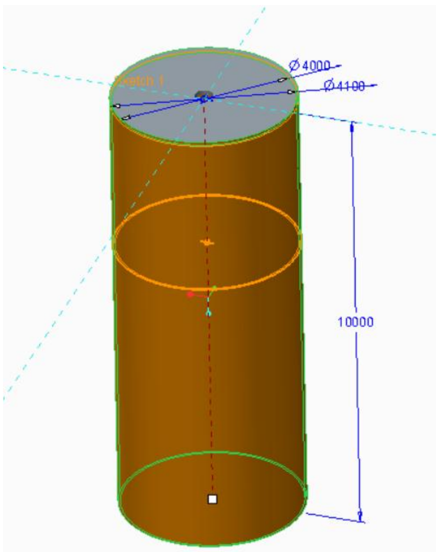

Fig4:- cleaning room

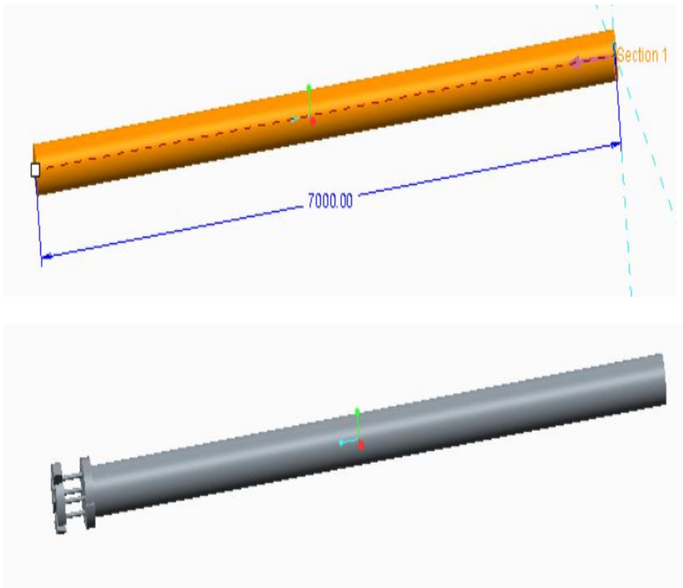

Fig5:- rod to hold the arms

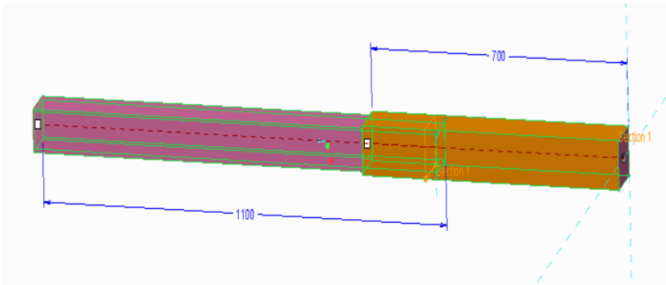

fig6:- arms to clean the surface of the room

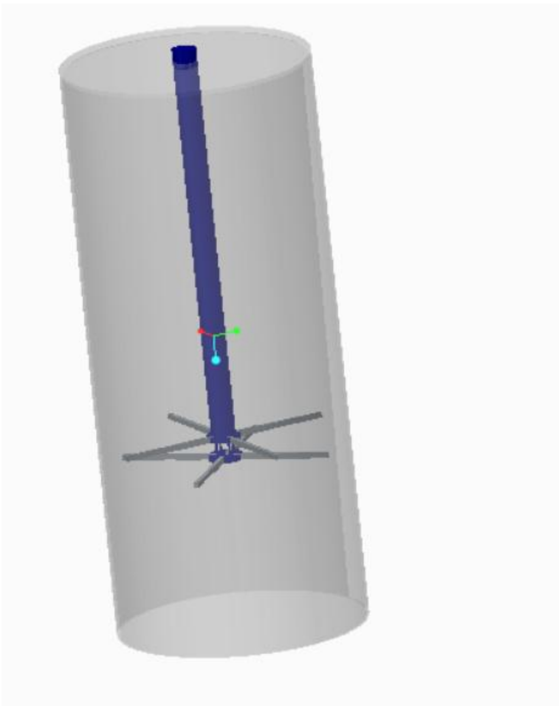

Fig7:- Final assembly

7. ANALYSIS ON SILO SURFACE CLEANING ROBOT

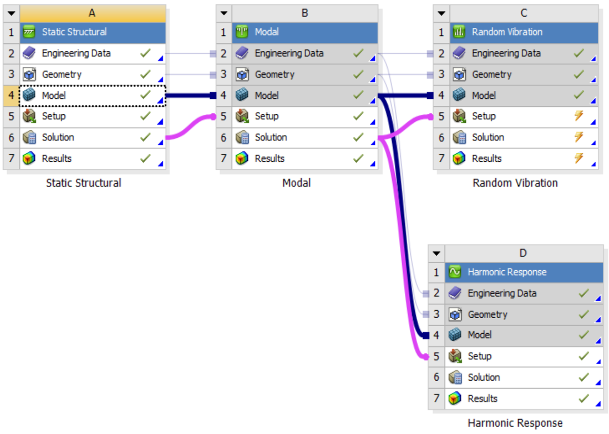

Fig8:- analysis

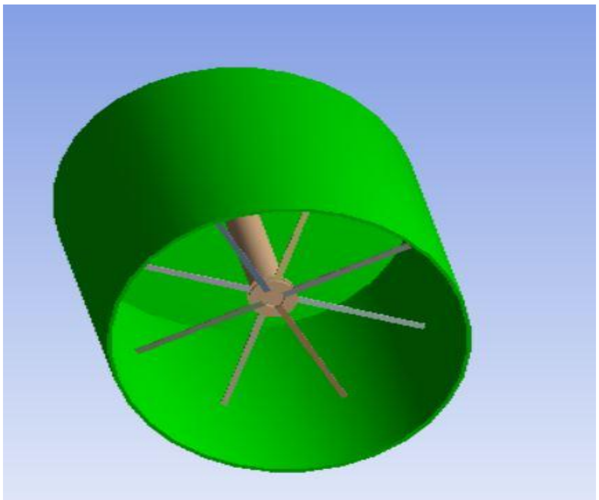

Fig9 – Imported model of silo surface cleaning robotfrom Creo 2.0

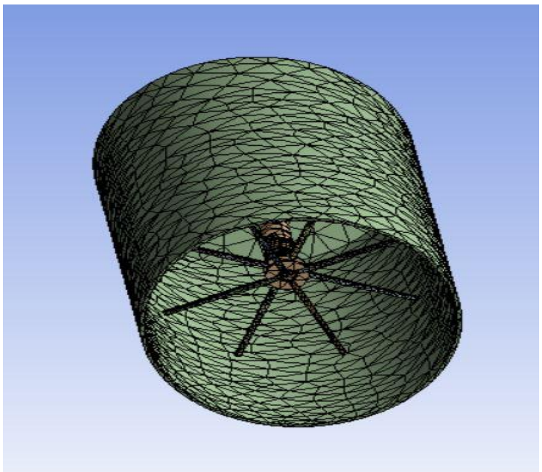

Fig 10– Meshed model of silo surface cleaning robot

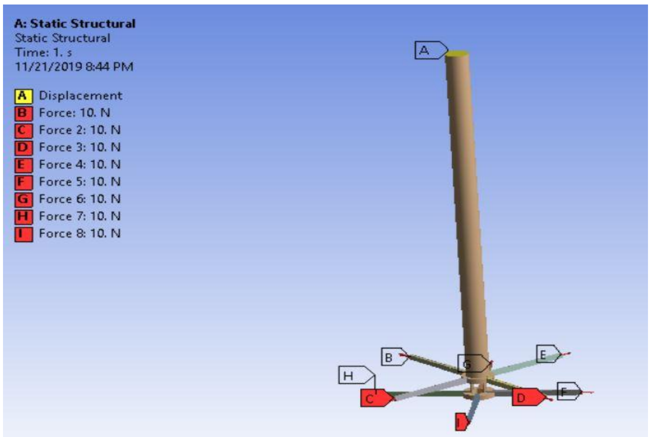

Fig 11– Force applied on silo surface cleaning robot

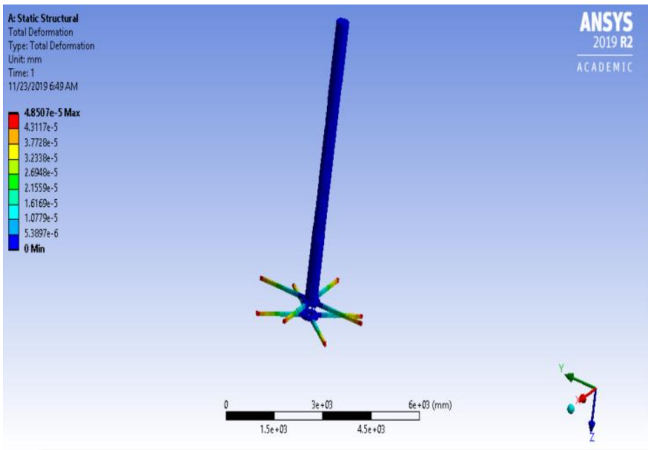

Fig12 - Total deformation of silo surface cleaning robot

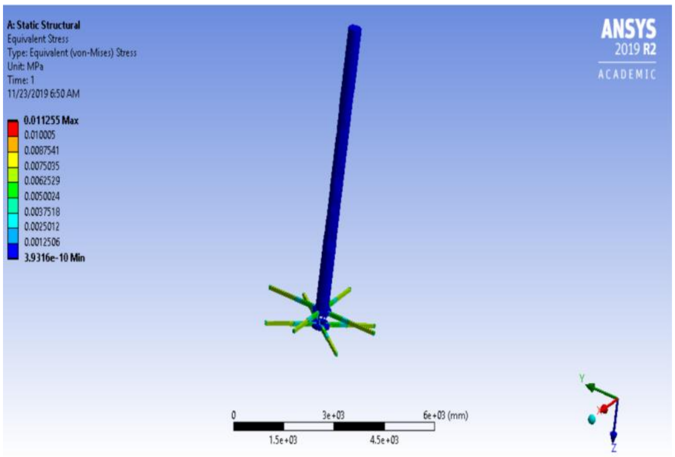

Fig13 – Equivalent Von-Mises Stress of silo surface cleaning robot

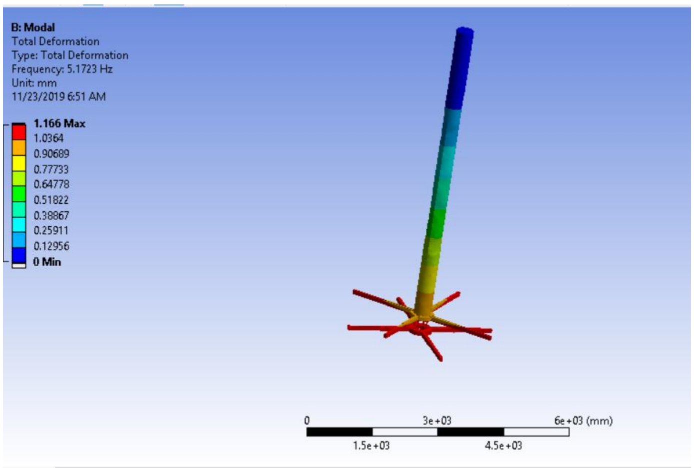

Fig14: Mode 1of silo surface cleaning robot

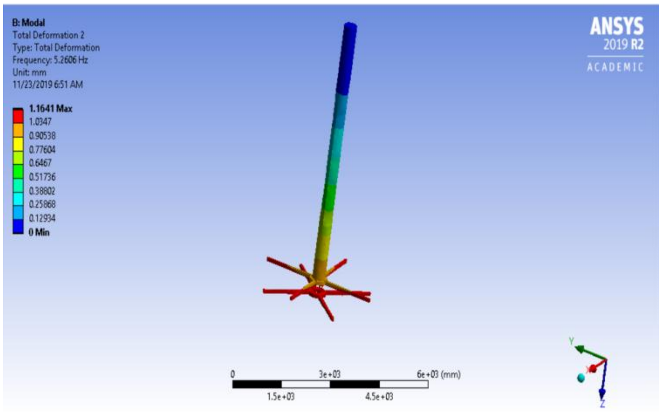

Fig15: Mode 2of silo surface cleaning robot

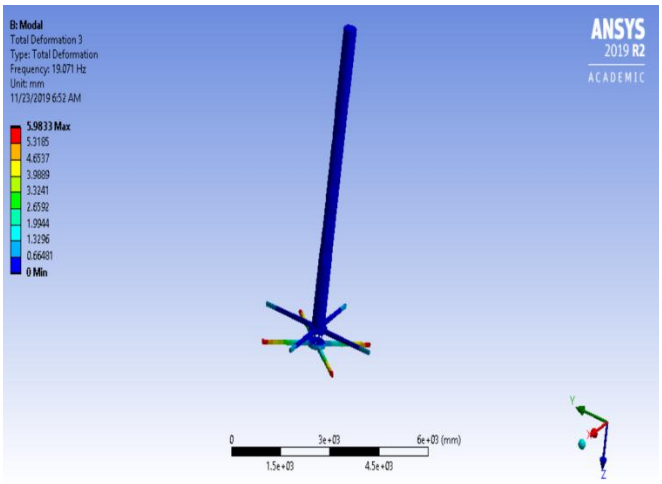

Fig16: Mode 3of silo surface cleaning robot

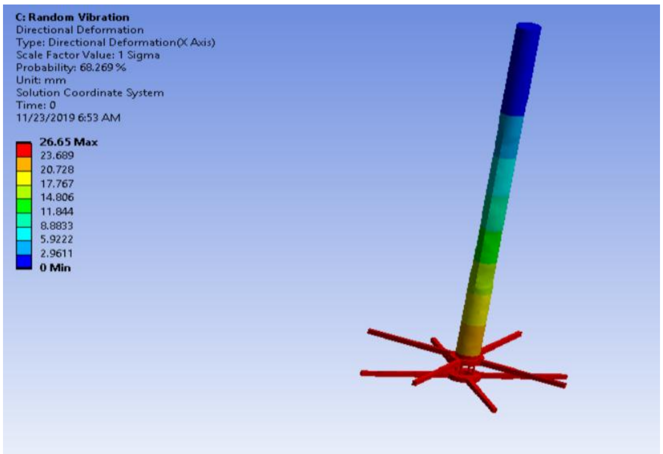

Fig 17– Directional Deformation

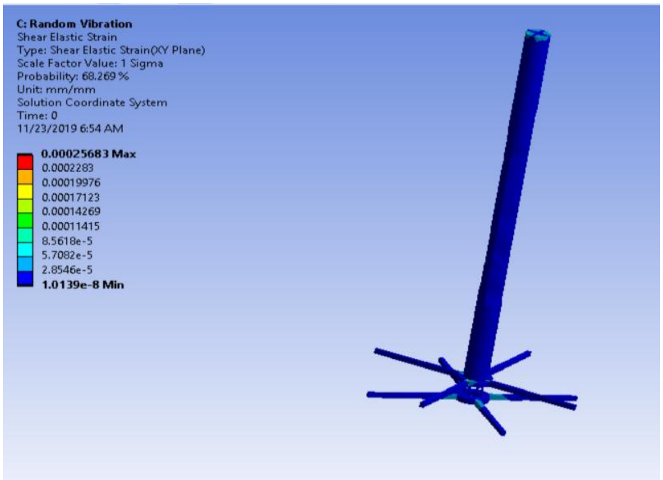

Fig18 – Shear Elastic Strain

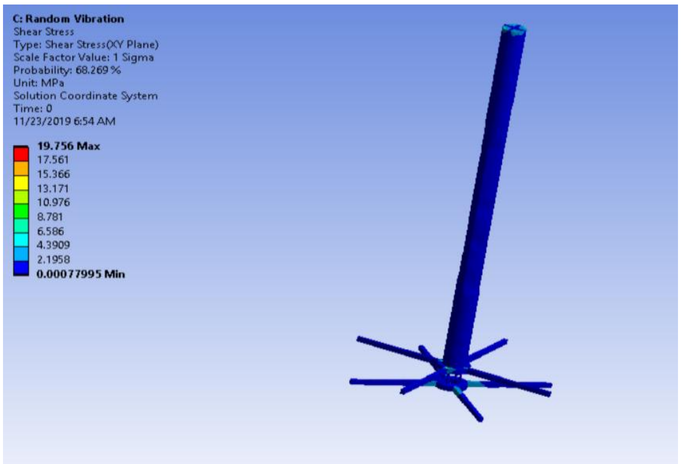

Fig 19– Shear Stress

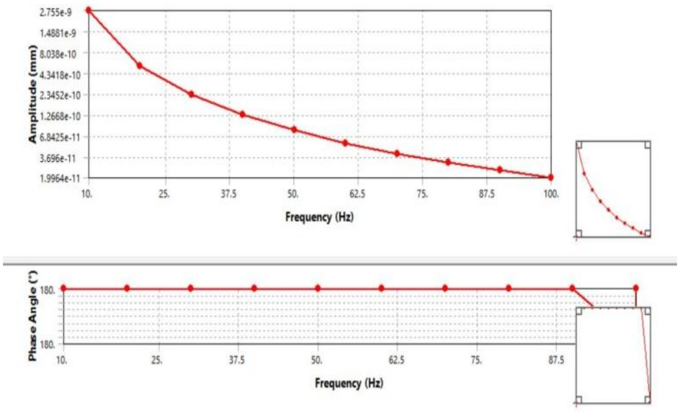

Fig20: frequency response for Deformation

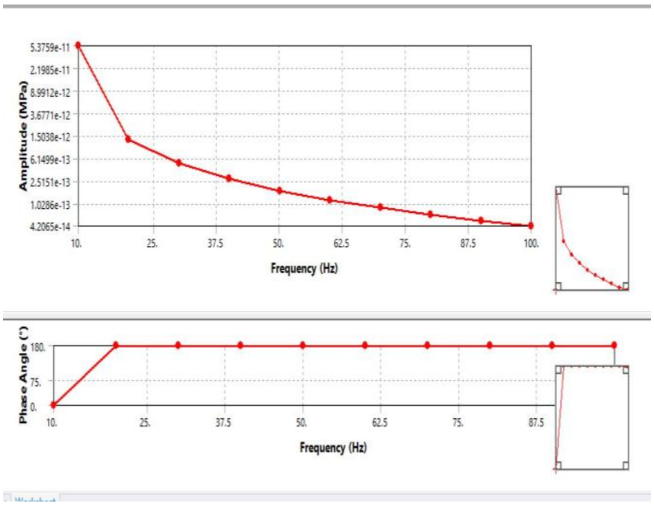

Fig21: frequency response for stress

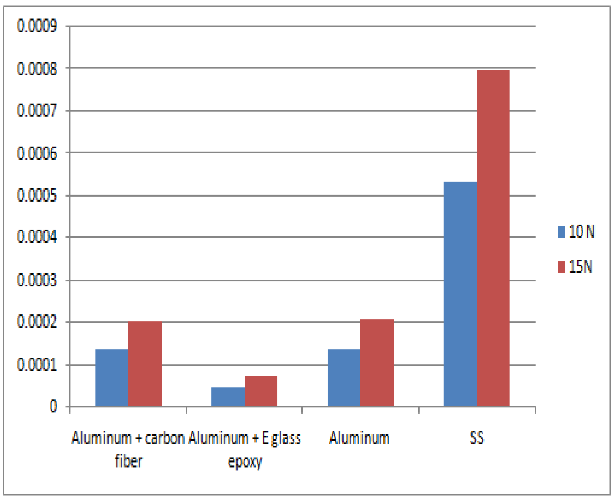

FIG22:- materials vs deformation (mm)

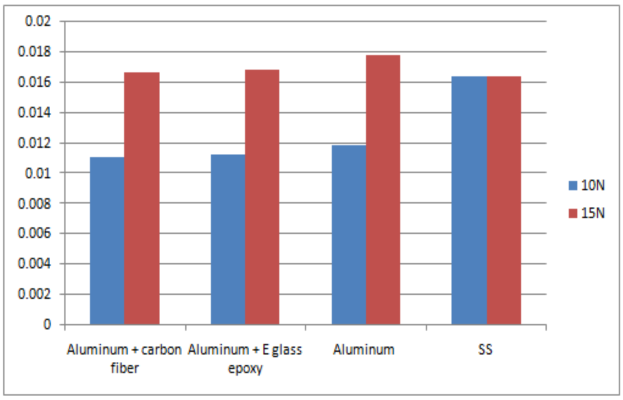

Fig23:- material vs stress (MPa)

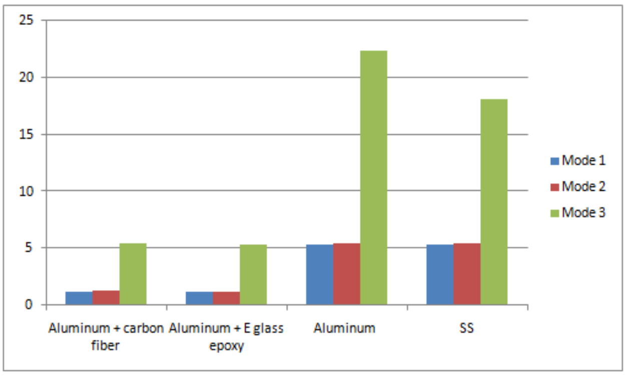

Fig24:- material vs different modes- frequency (Hz)

8. CONCLUSIONS

In this thesis, finite element analysis is performed on the silo surface robot by applying different loads. 3D model of the robot is done in Creo 2.0. Static, Modal and Random Vibration analysis is done to determine displacements, stresses, frequencies. The analysis is conducted by varying the materials Steel and Aluminum alloy of the robot arm and at different loads. Analysis is done in Ansys.

By observing results, we can conclude that deformation, stresses and strain are low for while using carbon fiber for the arms of the robot when compares to regular usage of materials like steel and aluminum.

While in modal analysis, the frequency is also low for the combination of aluminum with composite material

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