DESIGN AND ANALYSIS OF AUTOMATED DRAIN CLEANING SYSTEM

A Project report submitted in partial fulfilment of the requirements for the award of the degree of

Bachelor of Technology

in

Mechanical Engineering

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APRIL 2023

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CERTIFICATE

This is to certify that the Project Report entitled **"Design and Analysis of Automated Drain Cleaning System"** being submitted by **T. Joji babu (319126520116), D. Danunjaya Rao (319126520074), M. Yaswanth Kumar (319126520096), T. Sai Sampath (319126520115), A. Arun Kumar (319126520063)** to the Department of Mechanical Engineering, ANITS is a record of the bonafide work carried out by them under the esteemed guidance of **Ms.K.V.RUKMINI.** The results embodied in the report have not been submitted to any other University or Institute for the award of any degree or diploma.

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INTERNAL EXAMINER 18.4.23

EXTERNAL EXAMINER 18/4/23

ACKNOWLEDGEMENT

We express immensely our deep sense of gratitude to **Ms. K.V. RUKMINI, M.E, (**Ph.D.)**, Assistant Professor**, Department of Mechanical Engineering, ANITS, for her valuable guidance and encouragement at every stage of the work made it a successful fulfilment.

We were very thankful to our **Prof. K. SRI RAMA KRISHNA**, Principal, ANITS and **Prof. B. NAGA RAJU**, Head of the Department, Department of Mechanical Engineering, ANITS for their valuable suggestions.

Last but not least, we would like to convey our thanks to all who have contributed either directly or indirectly for the completion of project work.

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ABSTRACT

The proposed conception is to replace the manual work in drain cleaning by automated drain cleaning system. Now-a-days indeed though mechanical drainage plays a vital part in all domestic and artificial operations in the proper disposal of sewages from domestic, diligence and commercials are still a grueling task. Drainage pipes are using for the disposal and unfortunately occasionally there may be loss of mortal life while drawing the blockages in the drainage system. In India disposal of solid waste is major issue, according to the sources 80 percent of solid waste is disposed in drainages, swash, lake and other water bodies. The solid waste like plastic bottles, polythene bags, soft drink barrels, solids crap etc., are substantially flow with these lines which need to filter stage to stage, else this solid waste can be get blockage of these lines which tends to submerge like situation in stormy season.

To avoid this kind of situations this waste is demanded to be taken out of the drainage for nonstop inflow of drainage water. This will reduce the problem faced in homemade drainage cleaning. This system will help to reduce conditions causes due to the sewage water like malaria, dengue, typhoid etc. The Automated Drain cleaning system is a machine which helps to cover the terrain from different kinds of environmental hazards by the junking of scrap from the drainage system. To overcome this problem and to save mortal life we enforced a design " Automated Drain cleaning system " and have designed our design in solid workshop and further performed analysis in Ansys workbench to carry further cargo and to repel in optimum conditions which is an effective way for regular filtration of extinctions.

Keywords- automated drain cleaning system, mechanical drainage, solid waste disposal, filtration, environmental hazards, mortal life, ANSYS Workbench, optimization, regular filtration.

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CHAPTER 1
INTRODUCTION

Water is being used veritably wider in moment. The waste water used in the plant and the house flows through the rainspouts and reaches the gutters, ponds and abysses, in which more solid constituents(polythene, bottles, etc.) along with water also reaches. We've designed an automated drain cleaning system with the main purpose of removing these solid accoutrements from drains. This machine can be established at any point of drain fluently. It has been designed in such a way that it lets water flow through it but collects all the solid substances and places in the collecting bin. This machine is suitable to do cleaning and moving process together on the rainspouts.

1.1 Use of automated system

The Drainage water cleaning system is used to clean wastes from water like polythene, bottles etc., which are present in water. This can be used to overcome the problem of filtration of wastes from water and it saves the time and cost that spend on drawing the drainage and the contaminations present in water can get dangerous conditions. As the assiduity setup adding in the terrain, the water coming from diligence are full of wastes like polythene, bottles, and other accoutrements .

Fig1.1 Manual gutter cleaning to remove solid waste

In this design, automated drain cleaning system using automation medium is proposed to overcome the real life problems. In this system we used sprocket, chain, motor, battery, collecting jaw, bin, frame.

1.2 Circumstances of manual cleaning

Drainage pipes are used for the disposal of sewage and unfortunately occasionally there may be loss of mortal life while cleaning the blockages in the drainage pipes. The workers are only responsible to ensure that the sewage is clean or not. Though they clean the dikes at the side of structures, they can't clean in veritably wide sewages. The workers need to get down into the sewage sludge to clean the wide sewage. It affects their health poorly and also causes skin disinclinations. With the continued expansion of diligence, the problem of sewage water must be urgently resolved due to the adding sewage problems from diligence to the girding terrain. To overcome this problem and to save the mortal life this design of automated drain cleaning system is proposed. The being system is designed in order to reduce the cargo of workers and to make clean India.

1.3 Benefits of automated drain cleaning system

The automated drain cleaning system provides multitudinous benefits compared to manual cleaning. Originally, it reduces the workload on the workers, which in turn saves time and labor cost. This system is also largely effective and accurate in removing solid accoutrements from rainspouts, and it can handle large volumes of waste accoutrements with ease. likewise, the automated system is designed in such a way that it can be fluently installed at any point of a drain, which makes it largely flexible and adaptable to different surroundings. It also has a low conservation cost, which ensures its continuity and long-term treatability. In addition, the use of this system contributes to environmental conservation by precluding the pollution of water bodies due to the discharge of solid waste accoutrements . The accumulation of solid waste accoutrements in water bodies not only poses a health threat to humans and creatures but also causes aesthetic pollution. By removing these accoutrements from the water, the automated drain cleaning system promotes a cleaner and safer gutter for everyone.

Overall, the automated drain cleaning system is an innovative result to the problem of solid waste accumulation in drainage systems. Its benefits are multitudinous, ranging from perfecting the health and safety of workers to promoting environmental conservation. An automated drain cleaning system is a machine designed to remove solid waste from rainspouts, gutters, and other water channels using an automated medium.

The system is designed to overcome the challenges associated with manual cleaning, which includes health hazards, labor- ferocious work, and low effectiveness. The system consists of components similar as a sprocket, chain, motor, bin, battery and frame, which work together to remove solid waste from the water and collect them in a bin.

The automated drain cleaning system can be fluently installed at any point of a drain and can handle large volumes of waste with ease.

The automated drain cleaning system are multitudinous, ranging from reducing the workload on workers to promoting environmental conservation. The system contributes to precluding the pollution of water bodies due to the discharge of solid waste accoutrements , which poses a health threat to humans and creatures and causes aesthetic pollution. This report will cover aspects of automated drain drawing systems, including its factors, working medium, benefits, and operations.

The report will also give an overview of the being technologies and systems available in the request, and their strengths and sins. also, the report will examine the profitable feasibility and eventuality of enforcing an automated drain cleaning system in different settings. likewise, the report will bandy the challenges and limitations of enforcing an automated drain cleaning system, including the installation and conservation, technological limitations, and environmental enterprises.

Fig 1.2 Manual drain cleaning

1.4 Parts of an automated drain cleaning system

1.Shaft

- The shaft in an automated drain cleaning system is a critical component that connects the motor to the pump, transferring power from the motor to the impeller of the pump. The shaft is typically a long, cylindrical metal rod that runs through the center of the pump housing and is supported by bearings at both ends.
- The shaft is typically made of a strong, durable material, such as stainless steel or hardened steel, to withstand the high torque and rotational forces generated by the motor. It must also be precisely machined and balanced to ensure smooth and reliable operation, minimizing the risk of vibration, noise, or other issues that can affect the performance of the system.
- One important consideration when selecting and designing the shaft for an automatic drain cleaning system is the type of coupling used to connect the shaft to the motor and pump. The coupling must be strong and secure, while also allowing for some degree of flexibility to accommodate any misalignment or movement between the motor and pump.

- Another important consideration is the size and shape of the shaft, which must be compatible with the size and type of pump being used. The shaft must be able to transmit the required amount of power from the motor to the impeller of the pump.

2.Chain

- In an automatic drain cleaning system, a chain can be used to transfer power from the motor to the impeller of the pump. A chain is a flexible series of metal links that is driven by a sprocket, a toothed wheel that meshes with the chain and provides torque and rotational force.
- One of the main advantages of using a chain in an automatic drain cleaning system is that it allows for the transmission of power over longer distances. This means that the motor can be located farther away from the pump, allowing for greater flexibility in system design and layout. Chains can also provide greater control over the speed and torque of the system, allowing for precise adjustment and operation.
- When selecting a chain for use in an automatic drain cleaning system, it is important to choose a chain that is properly sized and rated for the specific application. This includes considering factors such as the speed and torque required, the distance between the motor and pump, and any other environmental or operational considerations.

3.Sprocket

- In an automatic drain cleaning system, a sprocket is a toothed wheel that is used to drive a chain or belt, transferring power from the motor to the pump. The teeth on the sprocket mesh with the links on the chain or the teeth on the belt, providing torque and rotational force.
- One of the main advantages of using a sprocket in an automatic drain cleaning system is that it allows for precise control over the speed and torque of the system. By selecting the appropriate size and number of teeth on the sprocket, the speed and torque of the system can be adjusted to meet the specific requirements of the application.

- When selecting a sprocket for use in an automatic drain cleaning system, it is important to choose a sprocket that is properly sized and rated for the specific application. This includes taking into account factors such as the speed and torque required, the distance between the motor and pump, and any other environmental or operational considerations.
- Proper maintenance and care of the sprocket is also important for ensuring the long-term reliability and performance of the system. This may include regular lubrication of the teeth and bearings, periodic inspection and cleaning of the sprocket, and replacement of any worn or damaged components as needed.

4.Collecting bin

- Collecting bin is an important component of an automatic drain cleaning system that is used to collect and store debris, sediment, and other materials that are removed from the drain or sewer line during the cleaning process. The collecting bin is typically located near the end of the cleaning line and is designed to be easily accessible for cleaning and disposal of the collected material.
- In this automatic drain cleaning systems, the collecting bin may be equipped with a sensor or monitoring system to alert the operator when the bin is nearing capacity and needs to be emptied. This can help prevent overflows or blockages in the system that could lead to damage or downtime.
- Proper maintenance and cleaning of the collecting bin is important for ensuring the long-term reliability and performance of the automatic drain cleaning system. This may include regular emptying and disposal of the collected material, cleaning of the interior surfaces of the bin, and inspection of the bin and associated components for signs of wear or damage.

5.Lifter mounts

- Lifter mounts are one of the components of an automatic drain cleaning system that are used to securely attach and position the lifter assembly, which is responsible for raising and lowering the cleaning head or nozzle into the drain or sewer line.

- The lifter mounts typically consist of a set of brackets or clamps that are attached to the frame of the machine or to a support structure, such as a truck or trailer. The lifter assembly is then attached to the brackets or clamps using bolts or other fasteners, allowing for secure and stable mounting.
- Proper positioning and alignment of the lifter assembly is critical for ensuring the efficient and effective operation of the automatic drain cleaning system. The lifter mounts should be carefully selected and positioned to provide the necessary support and stability for the lifter assembly, while also allowing for easy adjustment and control of the lifting and lowering mechanism.

6.Motor

- The motor in an automatic drain cleaning system is a component that provides the power necessary to drive the pump and perform the cleaning operation.
- Electric motors are the most common type of motor used in automatic drain cleaning systems. They are typically powered by a standard electrical outlet and provide consistent, reliable power to the pump. Electric motors are also relatively quiet and easy to maintain, making them a popular choice for commercial and residential drain cleaning applications.
- Regardless of the type of motor used, it is important to choose a motor that is appropriately sized and rated for the specific drain cleaning application. This includes taking into account factors such as the size and type of pipe being cleaned, the length of the run, and the type and amount of debris or blockage present in the line. By selecting the right motor for the job, we can ensure that automatic drain cleaning system operates smoothly and effectively, providing a reliable solution for all your drain cleaning needs.

1.5 Problem Statement

Circumfluous or solid matters that are created by humans and beast conditioning which are inclined because of their dangerous nature is known as solid waste. Solid waste includes paper, plastic holders, bottles, barrels and electronic goods aren't biodegradable, which means they cannot be carried out through organic or inorganic processes. They beget health trouble to humans, shops, creatures etc. The contaminations present in the drainage can beget instant blocks. The cleaning of drainage system is carried out by manually. This is unsafe for mortal life and hence the idea of this design surfaced. The ideal of the proposed design is to design an automated machine for drainage cleaning in order to help humans from getting affected by conditions from the contagious microbes present in the sewage while drawing manually. This proposed system is to minimize or overcome the problem faced while using man operated machine and to minimize the increased jilting rate of waste. A device that could clean gutters, rainspouts without putting people in detriment's way of climbing a graduation onto the roof of a house would an ideal result. That's why an automated drain cleaner would be a great tool to use. The lack of automated drain cleaning systems can lead to a number of problems in colorful diligence and surroundings. One major problem is the buildup of blockages and debris in rainspouts, which can lead to clogs, flooding, and other issues that can disrupt operations, beget damage to structure, and indeed pose health and safety hazards. Overall, the lack of an automated drain cleaning system can lead to a range of issues that can affect the smooth operation and safety of installations, structure, and public spaces.

1.6 Problem Objectives

The problem objects are the list of features that are taken into consideration. The following is a list of problem objects and how they will be attained or measured to insure that the thing of the design was met.

- To design a machine which is easy to use and movements of corridor do easily.
- To design a device which is durable as it should be free from rust.
- To design the machine in accessible manner to separate the solid waste.
- Machine should be economically design.
- The plastic waste can be removed and allows only the water to pass through.
- The main ideal of this design is to reduce the mortal trouble in drawing the drainage system.
- The frequent blocks in the drainage system can be avoided which also offers the effective inflow of drainage water.

• Enhance Drain Cleaning Effectiveness Automated systems can give further thorough and harmonious cleaning of rainspouts, reducing the liability of blockages and other issues that can disrupt operations and pose health and safety hazards.

• Ameliorate Worker Safety by minimizing the need for manual cleaning, associations can reduce the threat of injury and illness for workers who may be exposed to dangerous accoutrements or dangerous surroundings during drain cleaning operations.

• Increase Environmental Sustainability by reducing the need for chemicals and minimizing the use of water and energy during drain cleaning operations, automated systems can help associations achieve their sustainability pretensions.

• Enhance Monitoring and Reporting by incorporating detectors and data analytics, automated systems can give real- time monitoring and reporting on drain conditions, allowing associations to identify implicit issues before they come serious problem.

1.7 Working Principle

Solid waste like bottle floating in the drain are lifted by plate with extended protrusions(or tooth) which is connected to chain. This chain is attached to sprockets which are fixed to shaft setup driven by a handle. When the handle is made to turn the whole chain assembly starts to rotate which results in upward stir of jaws. Solid waste lifted by the jaw and transported to the collector bin. Once the solid waste reaches the bin position through the transmitter the receiver will admit a signal through radio wave frequency communication.

The working principle of an automated drain cleaning system involves several factors and processes that work together to effectively cleans drains and gutters.

Overall, the automated drain cleaning system works by using advanced technology to efficiently and effectively clean rainspouts, reducing the need for homemade cleaning and conservation and perfecting the treatability and safety of the worker.

CHAPTER 2

LITERATURE REVIEW

As we know the cleaning of water is our primary purpose so drawing of water is done manually till now. When human cleans gutters manually, there are more chances for health issue which damage the mortal health. So we've designed a machine which clean gutters automatically and saves the mortal life by not getting effected to colorful conditions.

Ankita B. Padwal, et.al.[1] proposed the relief of mechanical work for drawing the drainage. Drainage substantially carries of solid wastes that forms as block over a period of time when it isn't gutted periodically. Due to this blockage, the flux of waste water has been affected and there's a chance of overflow in public places. A homemade labor work has been made to clean the wastes by sticks which may lead to high infection. To overcome this, they made a mechanical semi-automatic drain cleanser for the relief of man work.

Mhael Okpara, et.al.[2] reviewed about drainage cleaning to replace homemade work to automated system because manually drawing system it's dangerous for mortal life and cleaning time, is more so to overcome this problem they executed a design automatic drainage water pump monitoring and control system using PLC and SCADA. In this design the use of effective way to control the disposal of destruction.

K. Kumaresan, et.al.[3] explained homemade work converted to automated system. Drainage pipe using for disposal and it may be loss for mortal life while drawing the blockage in the drainage pipes. To overcome this problem they executed Automatic Sewage Cleaning System. They designed their design in different way of concurrence of gassy substance which are treated independently, so water will flow efficiently. They made their design provident and effective with the available coffers.

Ganesh U L, et.al.[4] showed the operation of mechanical drainage cleanser to replace the homemade work demanded for drainage cleaning system. Drainage pipes are truly dirty. occasionally is it dangerous for mortal life while it's demanded for drawing drainage system. To overcome this problem, they executed mechanical semi-automated drainage water cleanser and so the water flux is effective because of regular filtration of devastations with the help of that design. Different kinds of terrain hazards reduced with the help of drainage system machine.

James C, et.al.[5] proposed the design and construction of a new test machine configuration that offers same advantages over the traditional bone. The new machine and attendant instrumentation give further realistic chain lading and allowed list pressure and comber sprocket impact monitoring during normal operation. The objectification of idle sprocket allows independent adaptation of test on length and preload.

S D Rahul Bharadwaj, et.al.[6] proposed with the automatic cleaning of waste water in order to help global warming and melting of glaciers. The results emphasize the need of waste water treatment shops, through which the water is treated before suspending in gutters. originally power is generated and that power is used for waste water cleaning process.

Balachandra, et.al.[7] reviewed about drainage cleaning to replace homemade work to automated system because manually drawing system it's dangerous for mortal life and cleaning time is more. So to overcome this problem they executed a design Automated drainage water pump monitoring and control system using PLC and SCADA. In this design, to use effective way to control the disposal of destruction regularly, treatment of disposal in different way poisonous and nontoxic feasts. PLC regulator from Siemens was used in the treatment system of drainage wastewater control by the stepper motor, compressor, gas exhauster, pressure incline and the liquid position, flux and other analog variables to achieve Automated control of sewage waste water treatment.

Pramod Kumar, et.al.[8] proposed a design and development of an IoT based automatic drain cleaning system that uses sensors to monitor the drain status and trigger the cleaning process when necessary. The system is also equipped with a GPS module to track the location of the cleaning vehicle and ensure complete coverage of the drainage network.

Zhan Wei Liu, et.al.[9] presented a robotic system for automatic inspection and cleaning of stormwater drainage pipes. The system consists of a mobile robot that can navigate through the pipes, a cleaning mechanism that uses high-pressure water jets, and a sensing module that captures images and detects pipe defects.

S. Saravanan, et.al.[10] proposed a smart drain cleaning system that utilizes a combination of sensors, microcontrollers, and wireless communication to automate the cleaning process. The system is designed to operate on solar power and can be remotely controlled and monitored through a smartphone application.

N. N. Rajendran, et.al.[11] described a design and fabrication of a portable automatic drain cleaning machine that uses a centrifugal pump to generate high-pressure water jets for cleaning. The machine is compact, lightweight, and can be easily transported to different locations.

Scope of the work from Literature Survey

These research papers are very useful in design, analysis and optimization of the automated drain cleaning system. Researchers used many different methods and software for design, analysis and optimization. Researchers used different 3D modelling software like Pro-E, Catia, Solid works etc. Optimization can be done by changing the design and increasing the capacity to carry more load and performing analysis to withstand optimum conditions and placing a transmitter to communicate through radio wave frequency.

CHAPTER 3

METHODOLOGY

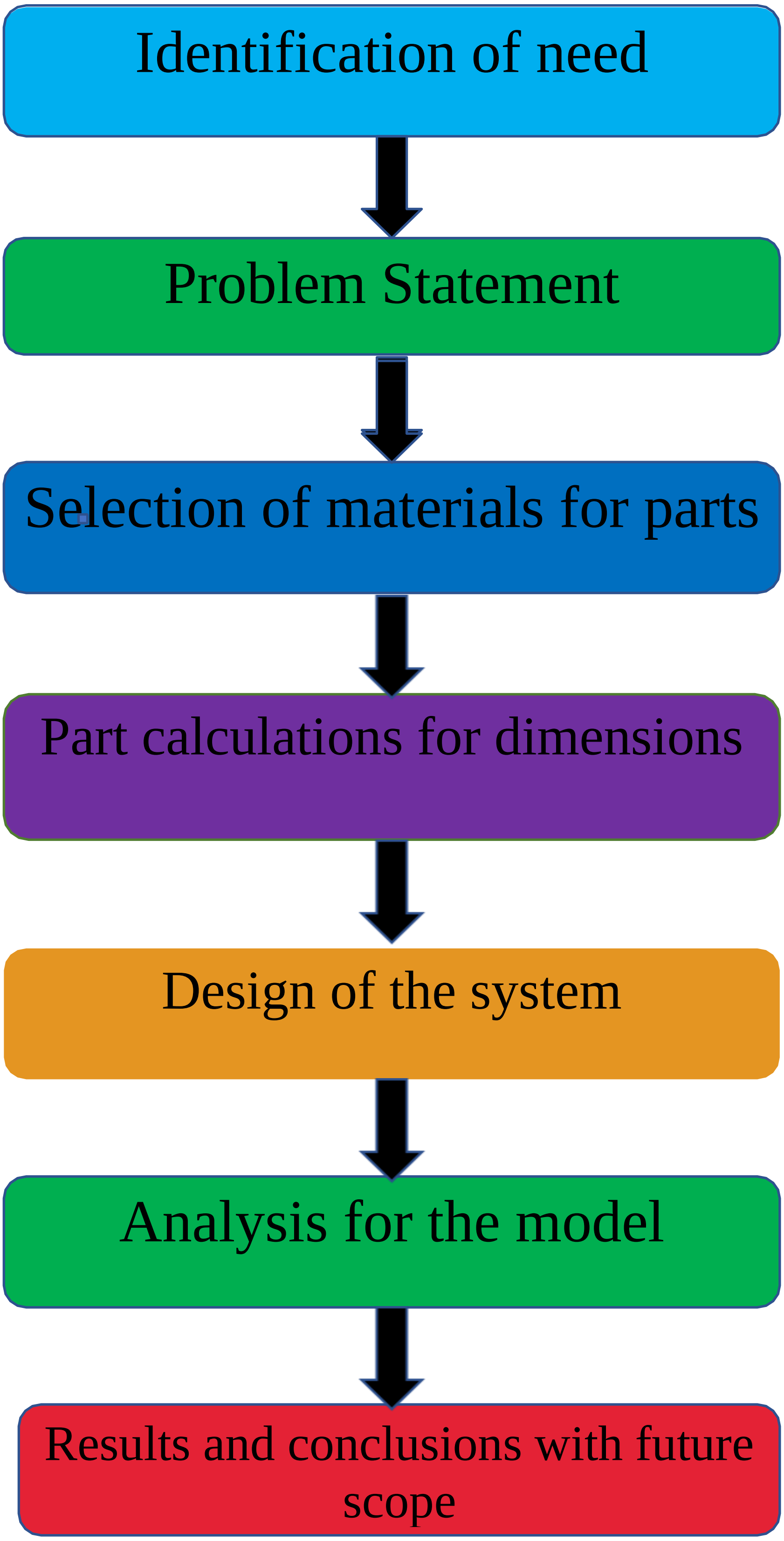
Our methodology outlines a systematic approach for the operation of the automated drain cleaning system. The system is designed to be placed over a drain, allowing only water to flow through the lower basement. Any floating waste such as bottles, plastic cans, and covers are collected by metal teeth-based jaws which are connected to a chain. The chain is powered by a motor which is run on energy from a battery. As the motor runs, the chain rotates, causing the collecting jaws to lift up and any waste material to be lifted by lifter teeth and stored in a collecting bin.

Our system is designed to catch large solid waste such as bottles and plastic containers, while allowing liquid to flow freely. The metal teeth-based jaws are mounted on a frame that holds the system upright within the gutter. A filter basket is positioned above the mechanism to further prevent solid waste from passing through.

At specific intervals, the motorized shaft lifts the jaws using the chain, and then rotates them upside down to dump the collected waste into a collecting bin. A transmitter is placed on the prototype which sends a radio frequency signal to a receiver when the collecting bin reaches its optimum level. This signal indicates that the receiver person should remove the solid waste materials from the collecting bin.

In summary, our system is an automatic drain cleaning system that allows for the flow of fluid while catching large solid waste, using a chain-driven mechanism with motorized shafts and collecting jaws, all powered by a battery. The system also includes a signal transmitter to alert when the collecting bin is full and needs to be emptied.

Proposed approach for whole processing of Automated Drainage cleaning System is given below.



3.1 Material selection

The type of material should be properly selected considering the design and safety. The selection of material depends upon the following factors1) Mechanical Strength 2)Stability 3) Ductility 4) Design 5) Corrosion resistance

3.1.1 Mechanical Strength

Mechanical strength is a primary criterion for selecting materials suitable for any engineering application. The material selected for the drain cleaning system should have adequate strength to withstand the forces and loads that the system may encounter during its operation.

3.1.2 Stability

Stability refers to the ability of the material to withstand various operating conditions, such as temperature, radiation, atmospheric conditions, and fluctuations in temperature. The chosen material must be stable enough to endure these conditions without experiencing failure or breakdown.

3.1.3 Ductility

Ductility is the material's ability to stretch plastically without failing or breaking. The appropriate ductility level should be considered when selecting the material, and it should match the design of the system.

3.1.4 Design

Design is another crucial factor when selecting the material for the automated drain cleaning system. The material should be chosen according to the design of the system, considering the required strength and ductility levels.

3.1.5 Corrosion Resistance

Lastly, corrosion resistance is a crucial factor that should not be overlooked when selecting the material. The selected material should be resistant to corrosion to ensure the system's satisfactory performance and extended service life

3.2 Description of Material:

Therefore, after careful consideration of all these factors, structural steel is the best material for the automated drain cleaning system. Its chemical composition and mechanical properties provide it with the necessary strength, stability, ductility, design, and corrosion resistance, making it an ideal choice for this particular application.

3.2.1 Chemical Composition

Element	Percentage (%)
C	0.20
Si	0.80
Mn	1.70
P	0.025
S	0.015

Table 3.1 Chemical composition of Structural Steel

3.2.2 Mechanical Properties

Properties	Values
Young's Modulus	$2x10^5$ MPa
Poisson's Ratio	0.30
Density	7.85e-006 kg/mm^3
Thermal Expansion	1.2e-005 C^-1
Tensile Yield Strength	250.MPa
Compressive Yield Strength	250.MPa
Ultimate Tensile Strength	460.MPa

Table 3.2 Mechanical Properties of Structural Steel

3.3 Parts Selection for the system

3.3.1 Frame

The frame of a machine is a crucial component as it bears all the forces and stresses generated during its operation. After extensive calculations and analysis, we have chosen to use structural steel as the material for both the main and base frames of the machine. The material's properties ensure that it is capable of withstanding the forces and stresses that the machine may encounter during its operation.

3.3.2 Motor

The motor is responsible for converting electrical energy into mechanical energy, and for this machine, we require a motor with a speed of not more than 30rpm and a power of not more than 90 watts. After considering various options, we have decided to use a 12-volt and 7-amp wiper motor that meets our requirements.

3.3.3 Shaft

Shafts are crucial rotating elements that transmit power, and for this machine, we require a shaft with high strength, good machinability, high wear resistance, and good heat treatment properties. We have considered various materials such as carbon steels of grade 40C8, 15C8, 50C4, 50C12, as well as MS and EN8. After careful evaluation, we have selected 15C8 for the shaft, which meets all our requirements.

3.3.4 Chain and Sprocket

Chain and sprocket systems are commonly used to transmit power, and for this machine, we have selected a pintle chain and a six-inch sprocket that meet the standards available in the market and satisfy our requirements. The combination of these two components ensures that the power is efficiently transmitted to the relevant parts of the machine, enabling it to operate smoothly and efficiently.

3.3.5 Collecting bin and Lifting mounts

These parts can be designed and analyzed using structural steel which satisfies the requirements and has an ability to withstand at high conditions

3.4 Theoretical Analysis

In this section frame, motor and shaft calculations will be done to find out the diameter of shaft, safety factor whether the frame is able to carry the given load and power is calculated for the selection of motor.

3.4.1 Calculation for base frame

Assumptions

Total load on frame is about 10kg

F=mg=10x9.81=98.1N

This load is applied at the center.

3.4.2 Motor Calculation

Speed(N)=30rpm

Estimated weight of waste in collecting bin=5kg

Factor of safety = 1.5

Force=mg

=5x9.81

=49.05N

Torque = Force x Distance = 49.05x320

= 15.6568 N-m

Therefore, Maximum Torque = 15.6 x1.5=23.54Nm

Now,

Power = (2x3.14NT)/60 = (2x3.14 x30x18.8352)/60 = 73.96 watts.

Therefore, selecting motor of power of eighty-four watts so losses can be avoided

Voltage: 12 volts

Current: 7 amp

Speed: 30 rpm

3.4.3 Shaft calculation

power: 90 watts

speed: 30 rpm

Assume load factor

K1=1.75

T=49.019Nm

Assuming SAE1030 as material for shaft having S =296 Mpa.(from design data book)

Take Factor of safety (FOS)=2.5

r=Syt/2^fos   r=296/2x2.5

r=59.2 Mpa.

According to maximum principal stress theory

Now,

r=l6Td/πd3

59.2=16' D=16.15 mm.

Considering bending stress D=l6.15X 1.5

D=24.225 mm.

Selecting standard diameter of shaft from design data book.

Therefore D=25 mm.

CHAPTER 4

MODELLING AND ANALYSIS OF AUTOMATED DRAIN CLEANING SYSTEM

In this project, we are using Solid works version 2019 as a modelling tool.

4.1 About Solid works:

SolidWorks is a largely protean computer aided design(CAD) and computer aided engineering(CAE) program that enables solid modeling. This important software is primarily designed to run on Microsoft Windows, and it's published by Dassault Systems. SolidWorks has a rich history of elaboration since it was first introduced in November 1995 as SolidWorks 95. In 1997, Dassault Systems, which is well known for its CATIA CAD software, acquired SolidWorks, farther strengthening its position as a leader in the CAD assiduity. SolidWorks is a solid modeler that utilizes a unique parametric point grounded approach. This approach was originally developed by PTC (Parametric Technology Corporation) to create models.

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Fig 4.1: SolidWorks interface

Parameters in SolidWorks has a robust set of features that enable to produce and design complex models and assemblies with ease. One of the crucial factors of SolidWorks is the use of parameters, which are constraints that determine the shape or figure of a model or assembly. These parameters can be numeric or geometric and can be associated with each other through the use of relations, allowing for lesser design intent prisoner.

Design intent is pivotal in SolidWorks, and it's the way the creator of a part wants it to respond to changes and updates. SolidWorks allows to specify features and conditions similar as tangency, community, and concentricity to capture design intent directly. This means that the confines and relations drive the figure, not the other way around.

Building in the modelling process in SolidWorks generally begins with a 2D sketch, which can be supplemented by 3D sketches for advanced druggies. The sketch includes colorful figure rudiments similar as lines, bends, conics, and splines, and confines are added to define the size and position of the figure connections similar as tangency, community, and concentricity are defined using relations. These connections drive the figure, allowing for quick and easy changes to the model.

In an **assembly,** the original to sketch relations are mates. These allow for easy construction of assemblies by defining conditions similar as tangency, community, and concentricity with respect to individual corridor or factors..

SolidWorks also includes advanced making features like gear and cam follower mates that enable to model gear assemblies and directly reproduce the rotational movement of an factual gear train. Overall, SolidWorks is an important tool that allows for largely customizable design and modeling of corridor and assemblies, making it an inestimable asset for masterminds and contrivers.

Finally, **drawings** can be created either from parts or assemblies. Views are automatically generated from the solid model, and notes, dimensions and tolerances can then be easily added to the drawing as needed.

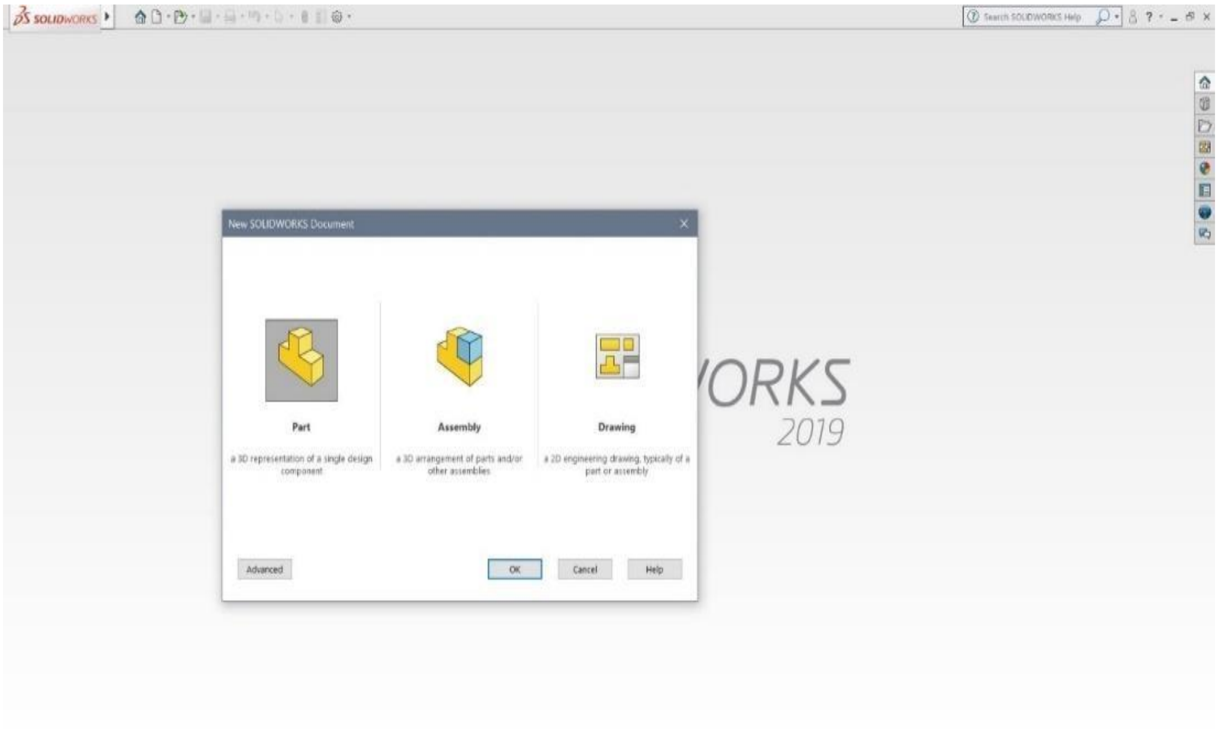

Fig 4.2: Solid Works Drawing Interface

4.2 SOLID WORKS FEATURES:

3D Interconnect

Solid works offers several features that make it a powerful tool for 3D CAD design. One of these features is 3D Interconnect, which allows for the seamless integration of open proprietary 3D CAD data. This feature enables users to work efficiently with anyone, regardless of the software they are using, and to incorporate design changes much faster.

Wrap Feature

Wrap Feature is the one which lets users create geometry on any face, not just cylindrical surfaces. This makes it easier to wrap a sketch on complex surfaces.

Advanced Hole Wizard

The Advanced Hole Wizard is another useful feature that allows users to create holes with multiple elements, defining them on either side. This eliminates the need for multiple hole wizard features for creating holes with different elements.

Sweep Profile

With the Sweep Profile feature, users can select faces, edges, and curves to create the same profile, eliminating the need to create a new sketch and convert entities.

Magnetic Mates

Magnetic Mates is another time-saving feature that allows users to click and drag parts or assemblies to snap them into place. This is especially useful when working with large layouts or common parts.

Latest Version Overwrite

The Latest Version Overwrite feature helps users save space on their servers by allowing them to check in the current version over the previous version, rather than saving every incremental version.

Offset On Surface

The Offset on Surface feature simplifies the creation of thickens, cut-outs, and junctions when working with complex geometry.

Dimensions

Finally, SOLIDWORKS has improved the dimensions feature, allowing users to attach the leader to an extended radius with the arc extension line or opposite side selected. Mirrored holes are also included in the total instance count when using hole callout. All these features contribute to making SOLIDWORKS a powerful and efficient tool for 3D CAD design.

4.3 DESIGN OF THE SYSTEM

4.3.1 SPROCKET

1. Create a new part file and select the desired units for the design.

2. Sketch the profile of the sprocket's teeth. We can use the "Centerline" tool to create a construction line that runs down the center of the sprocket's teeth. This will make it easier to ensure the teeth are evenly spaced and sized.

3. Use the "Circular Pattern" tool to replicate the teeth around the centerline. Now specify the number of teeth and the angle between them.

4. Extrude the teeth to the desired thickness. Use the "Thin Feature" option to create a thin-walled sprocket.

5. Create sketch on the back face of the sprocket and add a circle to represent the center bore. Dimension the circle to the appropriate size for your shaft.

6. Extrude the circle to create a hole through the sprocket. Use the "Through All" option to make sure the hole goes all the way through the sprocket.

7. Add additional features, such as a keyway or set screw holes.

8. Save the part file and use the "Make Drawing" option to create a 2D drawing of the sprocket, including dimensions and tolerances.

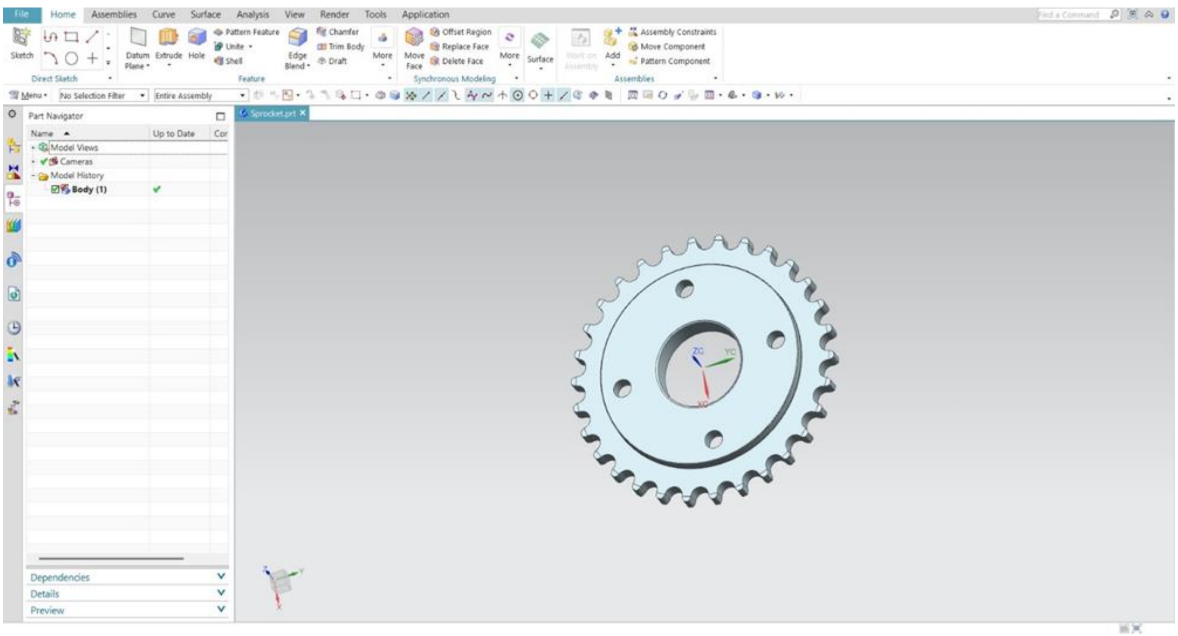

Fig 4 .3 Sprocket Model

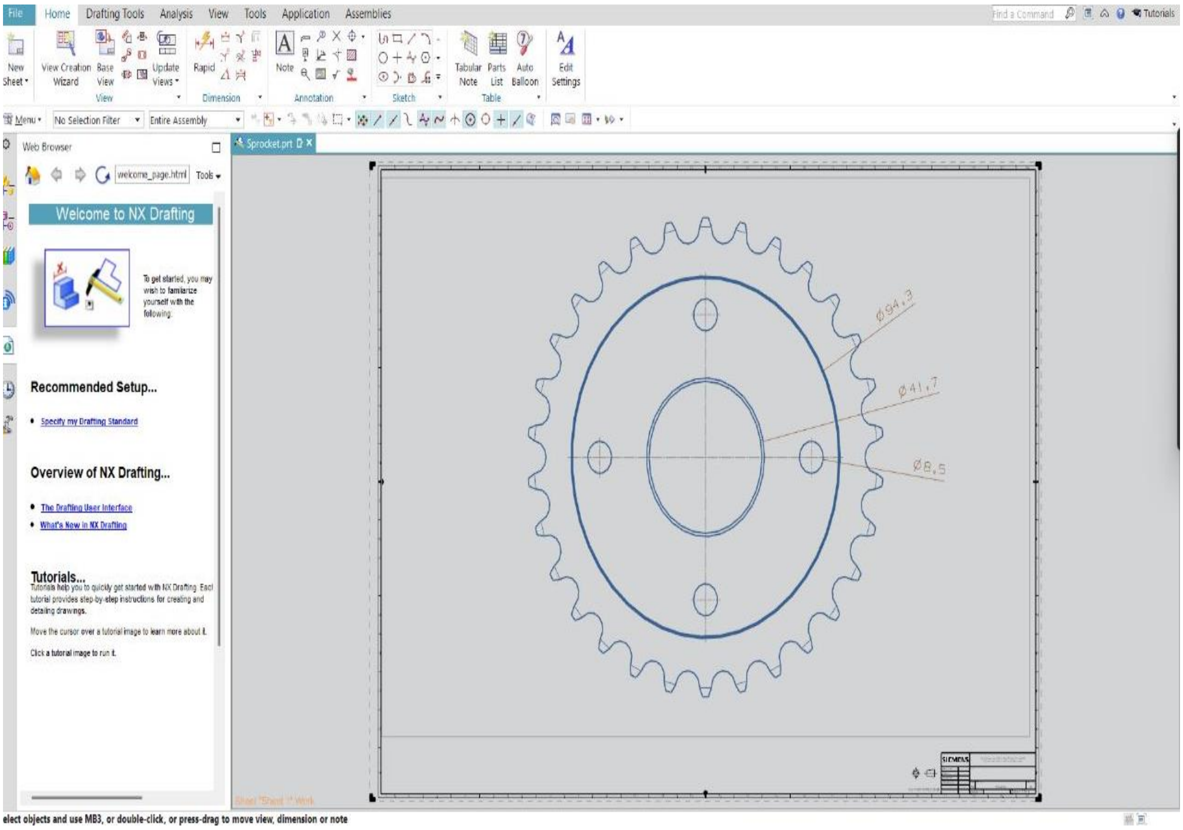

Fig 4.4 Drawing of Sprocket

4.3.2 SHAFT

1. Open a new part file in SolidWorks.

2. Create a sketch on the front plane and draw the profile of the shaft.

3. Use the "Revolve" feature to create a 3D shaft. To do this, go to the "Features" tab, select "Revolve Boss/Base", select the sketch you just created as the profile, and select the axis of revolution.

4.. Add necessary fillets or chamfers to the shaft using the "Fillet" or "Chamfer" features under the "Features" tab.

5. Add necessary features such as keyways or set screw holes.

6. Use the "Measure" tool to check the dimensions and make sure they meet the specifications.

8. Save the part file and export it to the appropriate file format for use in the project

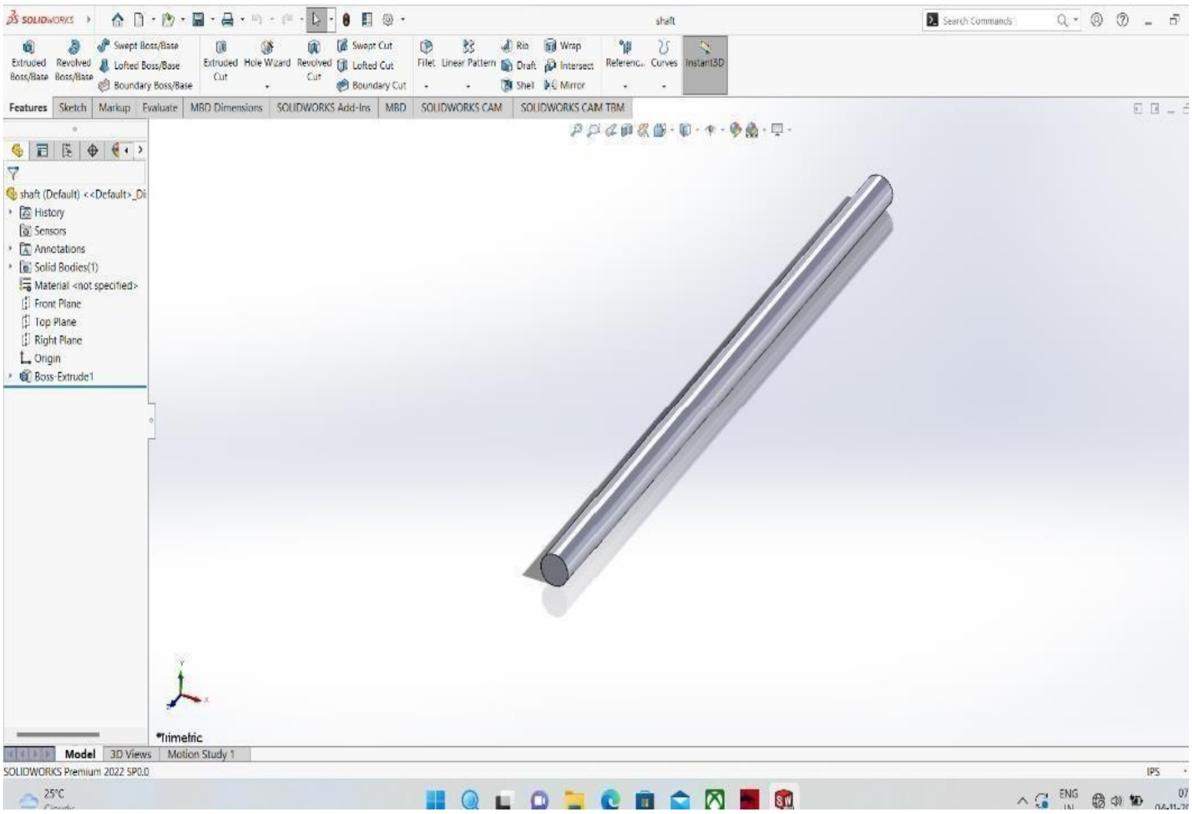

Fig 4.5 Shaft Model

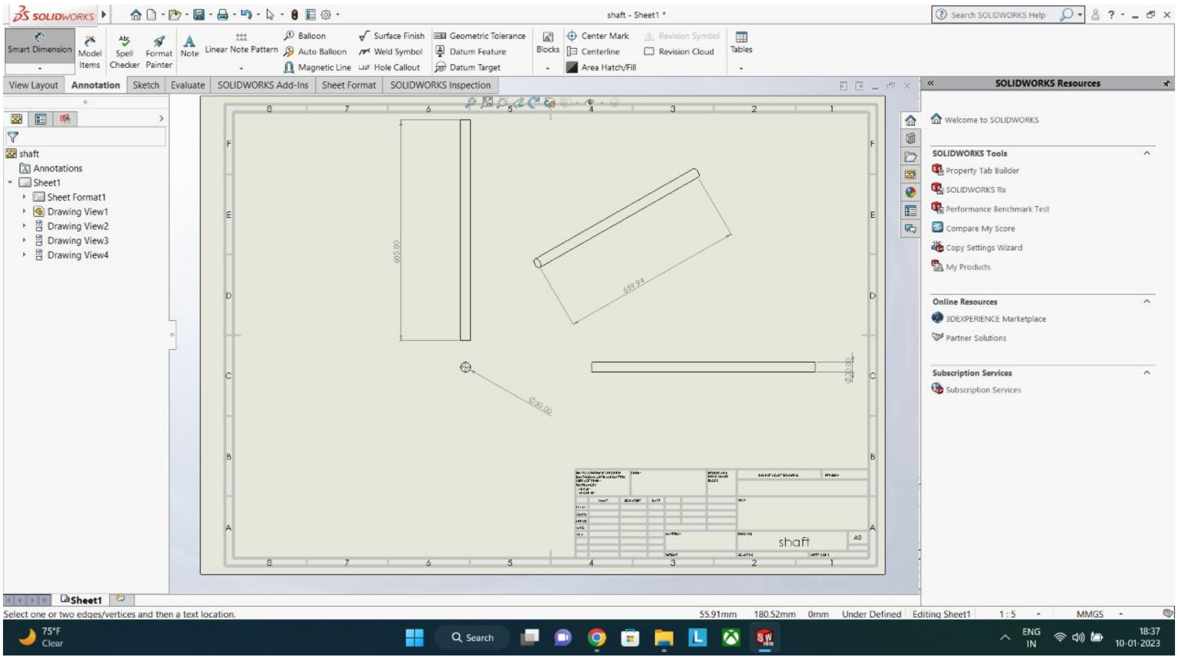

Fig 4.6 Shaft drawing

4.3.3 COLLECTING BIN

1. Use the Sketch tool to draw the bin's shape in 2D. You can use dimensions and constraints to ensure that the bin's proportions are correct.

2. Use the Extrude tool to create a 3D shape from the 2D sketch. Specify the thickness of the bin's walls and any other features, such as handles or hinges.

3. Use additional sketching and feature tools to add any additional details to the bin, such as a lid or bottom grate. Also use fillets or chamfers to round off edges and corners.

4. Use the Appearances tool to apply materials to the bin, such as plastic or metal. This will give the bin a realistic look.

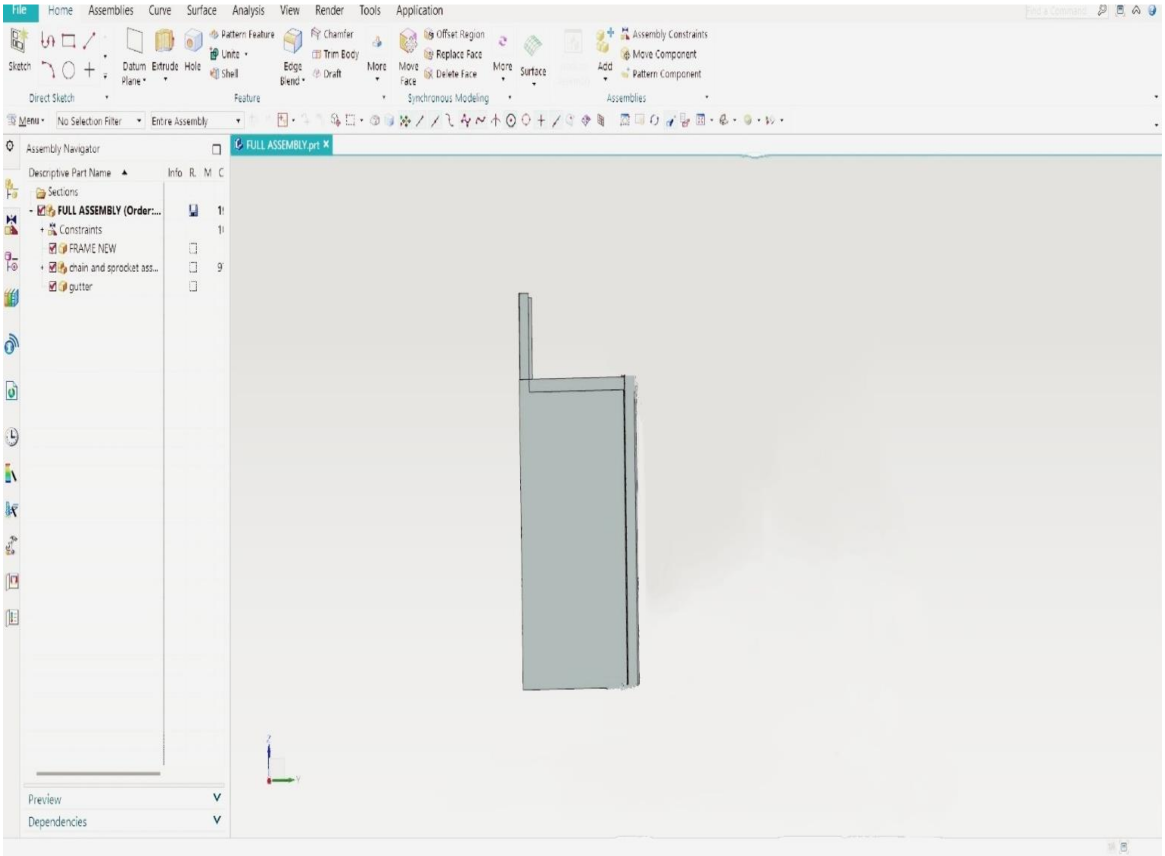

Fig 4.7 Collecting Bin Model

4.3.4 LIFTER MOUNTS

1. Create a new part file in SolidWorks. Start a sketch on the Front Plane.
2. Draw the outer shape of the gutter using lines, arcs, and other sketch tools.
3.Add dimensions and relations to fully define the sketch.
4. Extrude the sketch to create the base of the gutter.
5. Create a new sketch on the top face of the base.
6. Draw the shape of the lifter mount using sketch tools.
7. Add dimensions and relations to fully define the sketch.
8. Extrude the sketch to create the lifter mount.
9. Use fillet or chamfer features to round off edges and corners as needed.

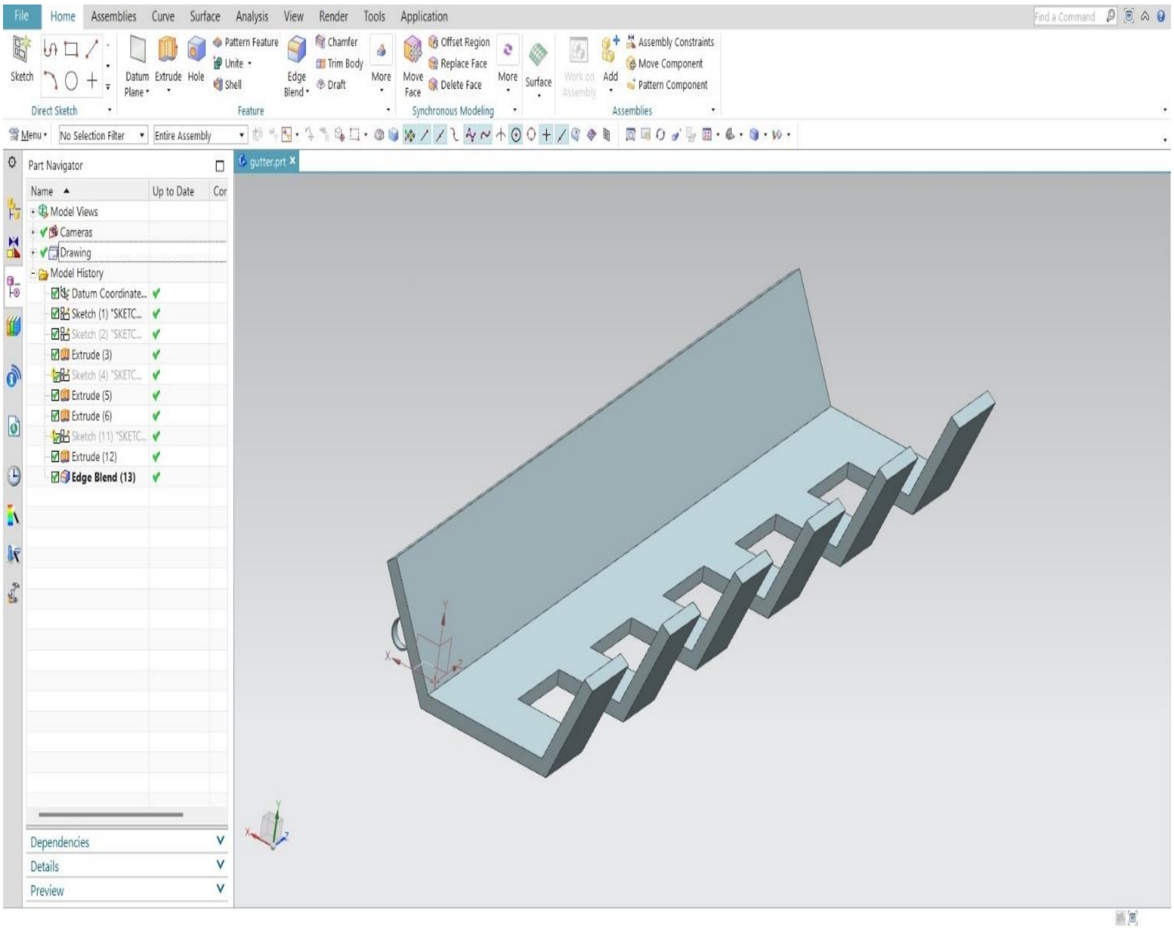

Fig 4.8 Lifter mounts Model

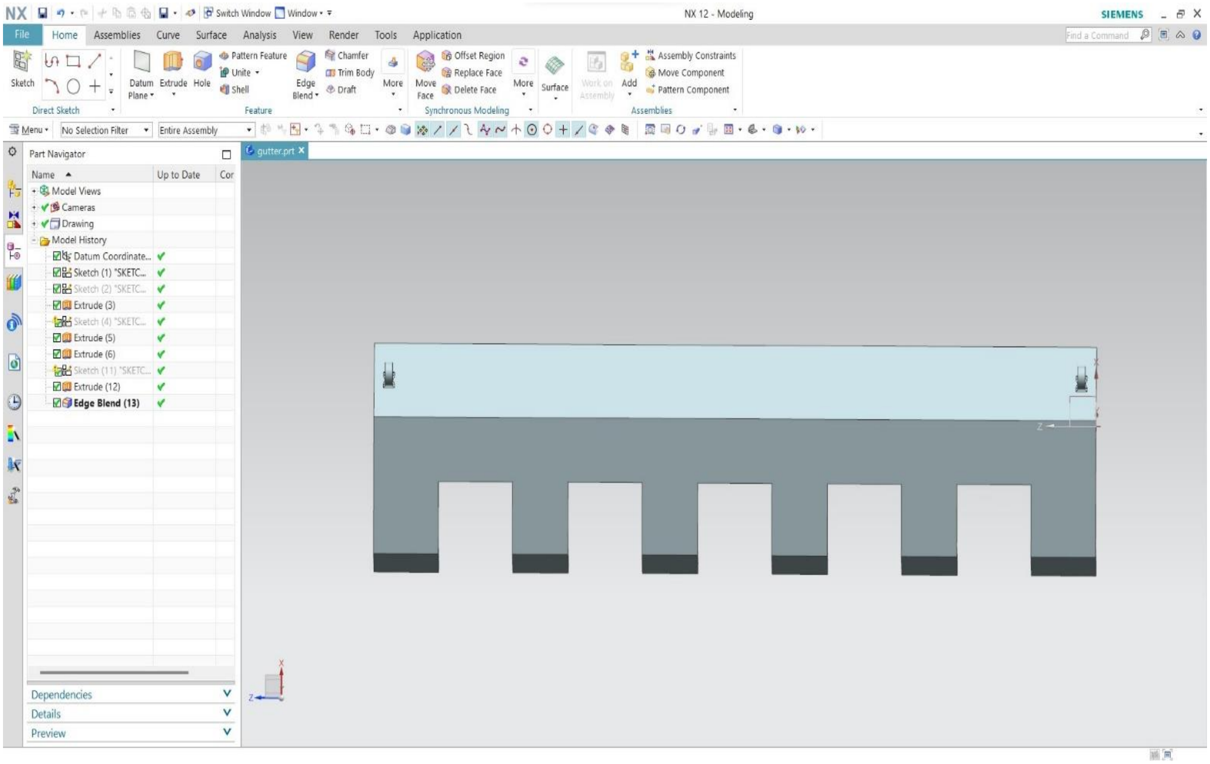

Fig 4.9 Lifter mounts side view

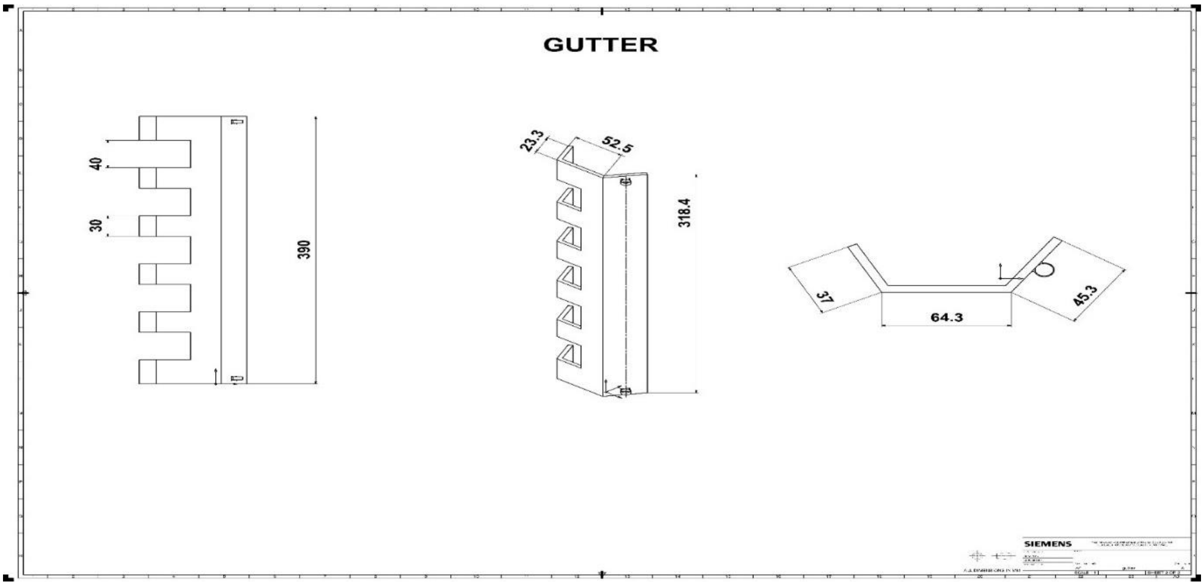

Fig 4.10 Lifter mounts drawing

4.3.5 CHAIN

1. Create a new part document in SolidWorks.

2. Sketch the profile of a single chain link. This can be done using the sketch tools, such as lines, arcs, circles, and fillets.

3. Extrude the sketch to create a 3D solid body. Adjust the thickness and other dimensions as needed.

4. Create a new assembly document in SolidWorks.

5. Insert the chain link part into the assembly document by dragging and dropping the part from the feature tree, or by using the "Insert Component" command.

6. Use the "Linear Pattern" or "Circular Pattern" command to create a series of chain links.

7. Specify the spacing, angle, and number of links in the pattern.

8. Add constraints and mates to connect the chain links together. This can be done using the "Mate" command, which allows you to specify how the parts should be positioned and aligned.

9. Test the assembly by moving the chain links using the "Move Component" command or by dragging them with the mouse.

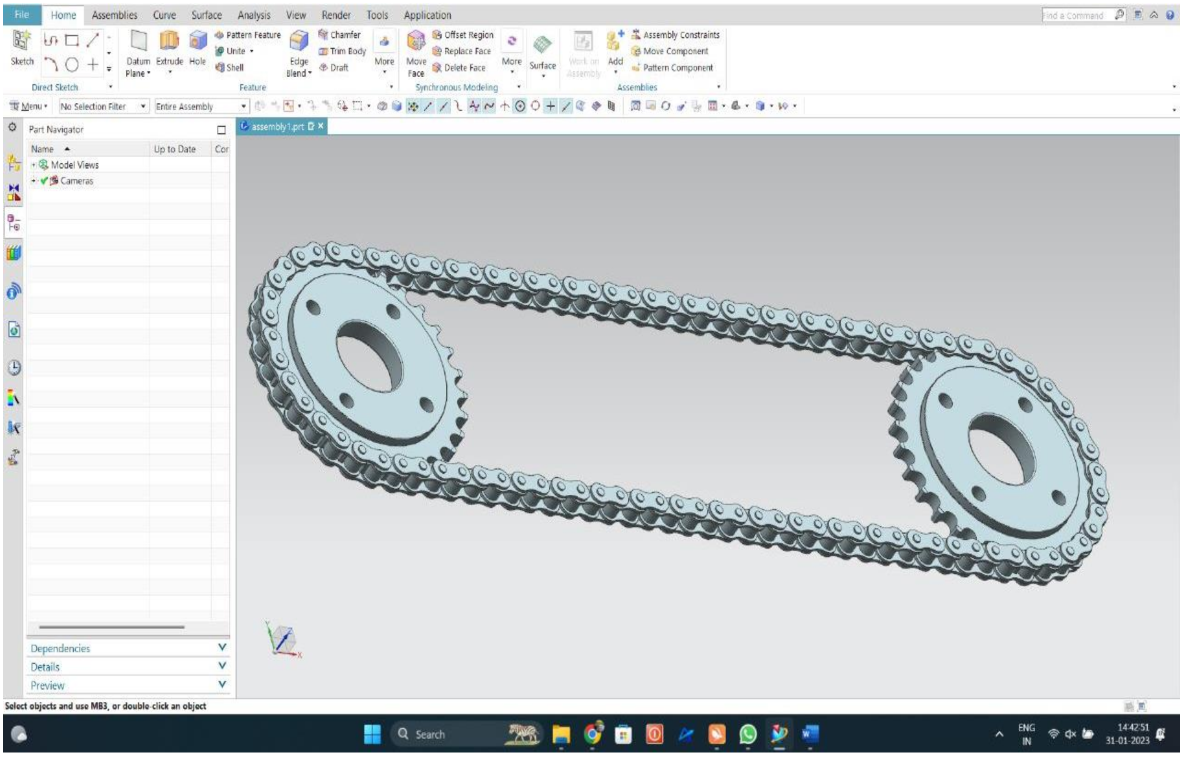

Fig 4.11 Chain Model

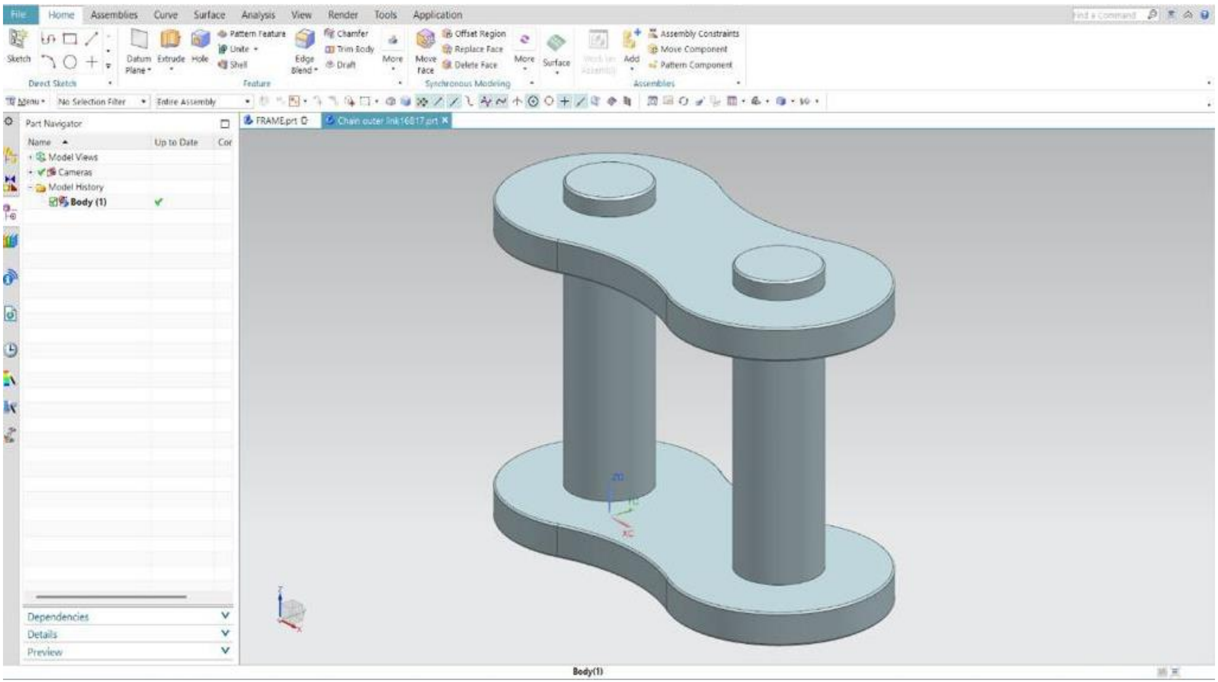

Fig 4.12 Inner link Model

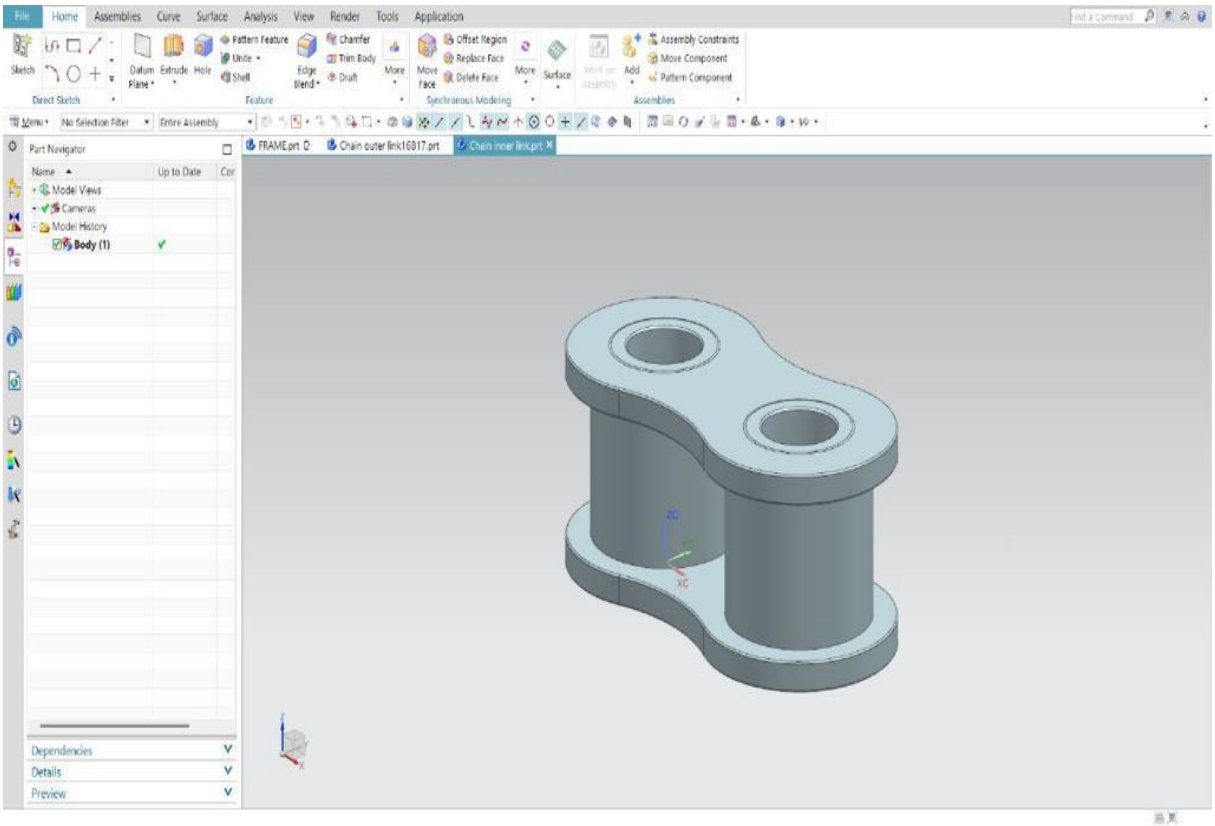

Fig 4.13 outer link Model

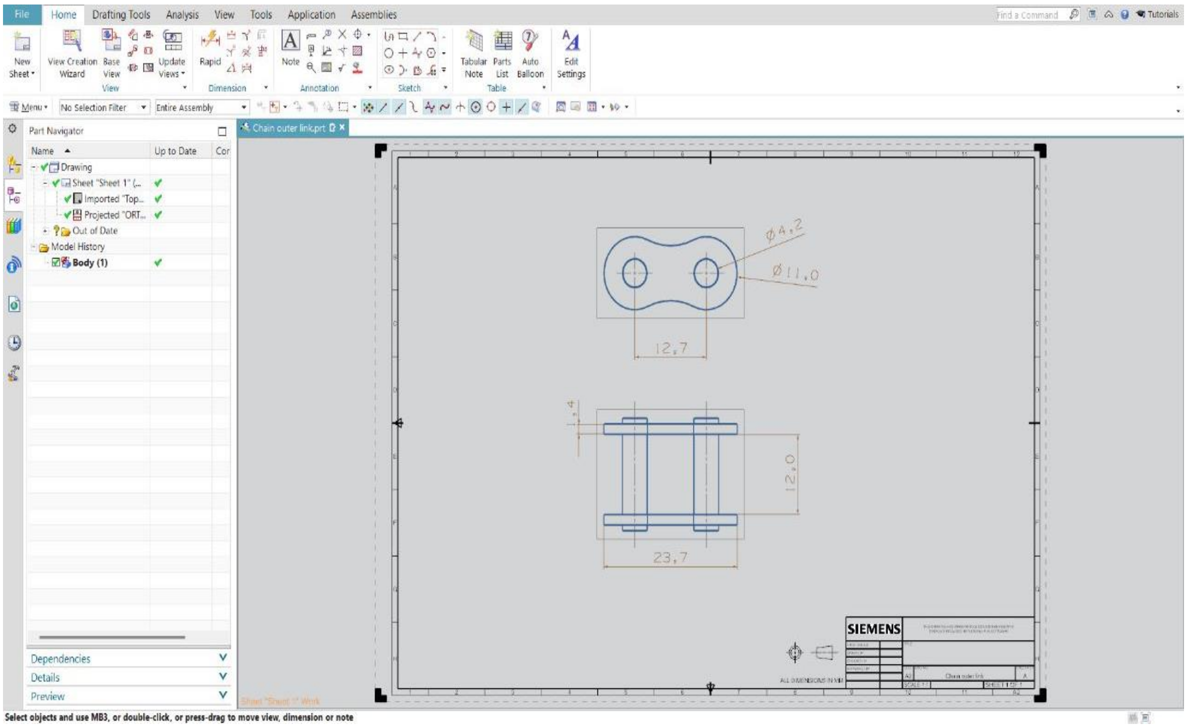

Fig 4.14 Inner link drawing

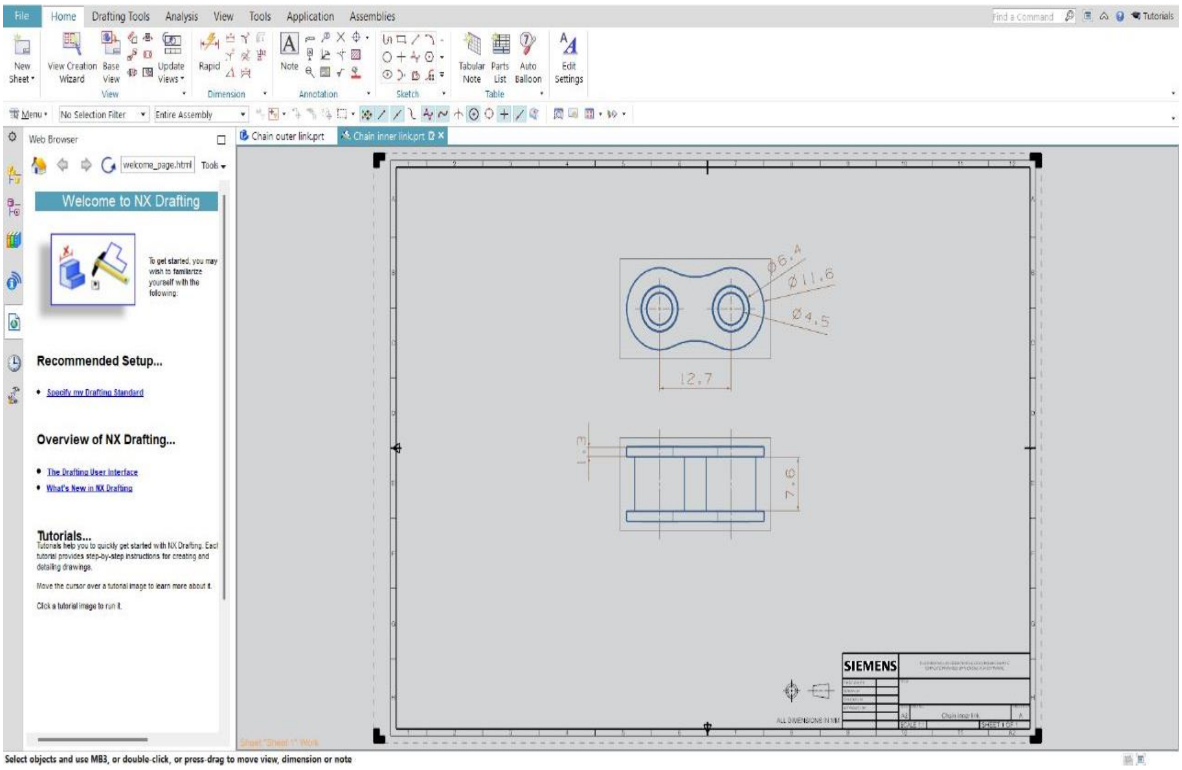

Fig 4.15 Outer link drawing

4.3.6 BASE FRAME

1. Open SolidWorks and create a new part file.
2. Create a sketch on the Top plane of the part file.
3. Use the Line tool to draw the outline of the base frame. Use other sketch tools, such as rectangles or circles, as well.
4. Use the Smart Dimension tool to set the dimensions of the base frame, such as the length, width, and height.
5. Use the Extrude tool to extrude the sketch to the desired height.
6. Add any necessary features, such as holes or fillets, using the appropriate SolidWorks tools.
7. Save the part file.

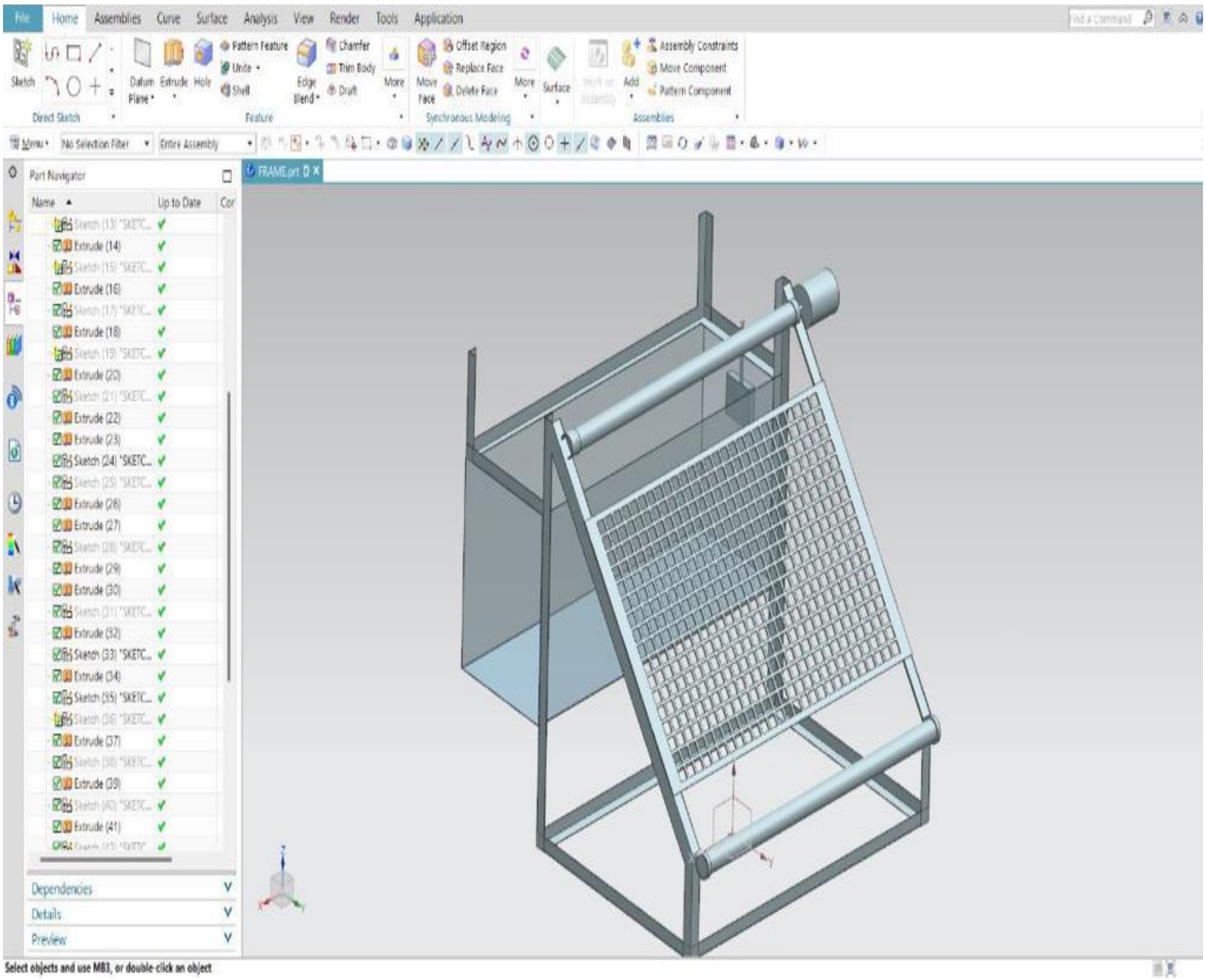

Fig 4.16 Base frame Model

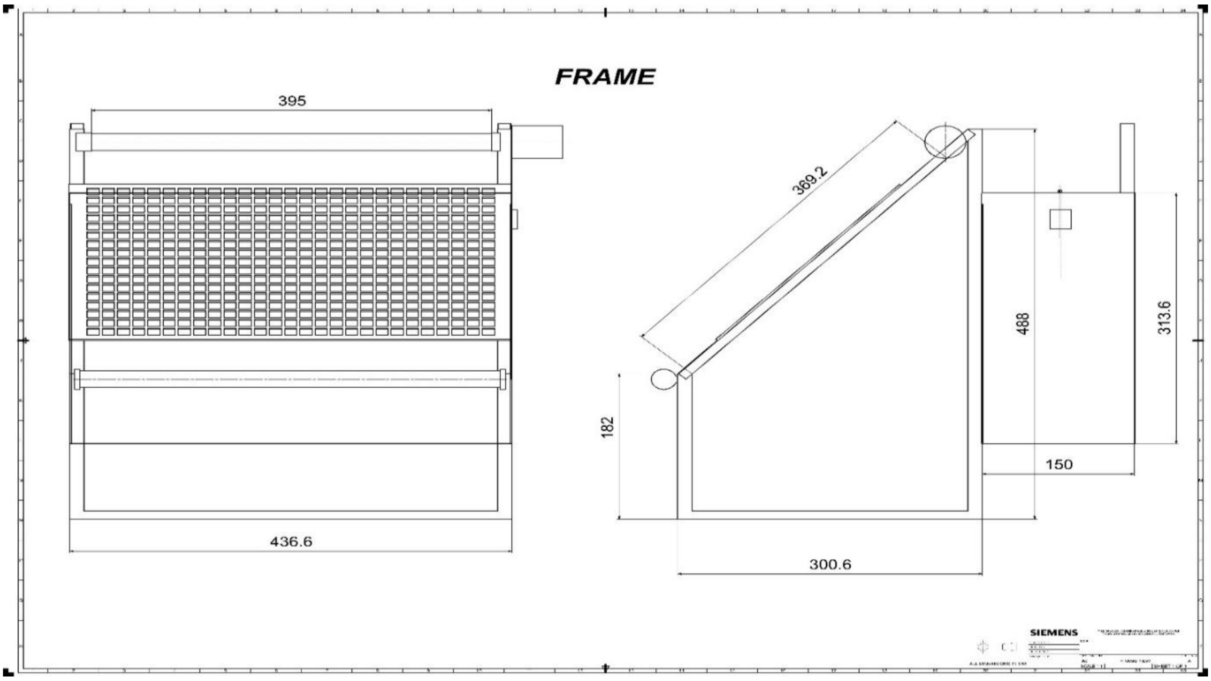

Fig 4.17 Base frame drawing

4.3.7 ASSEMBLY

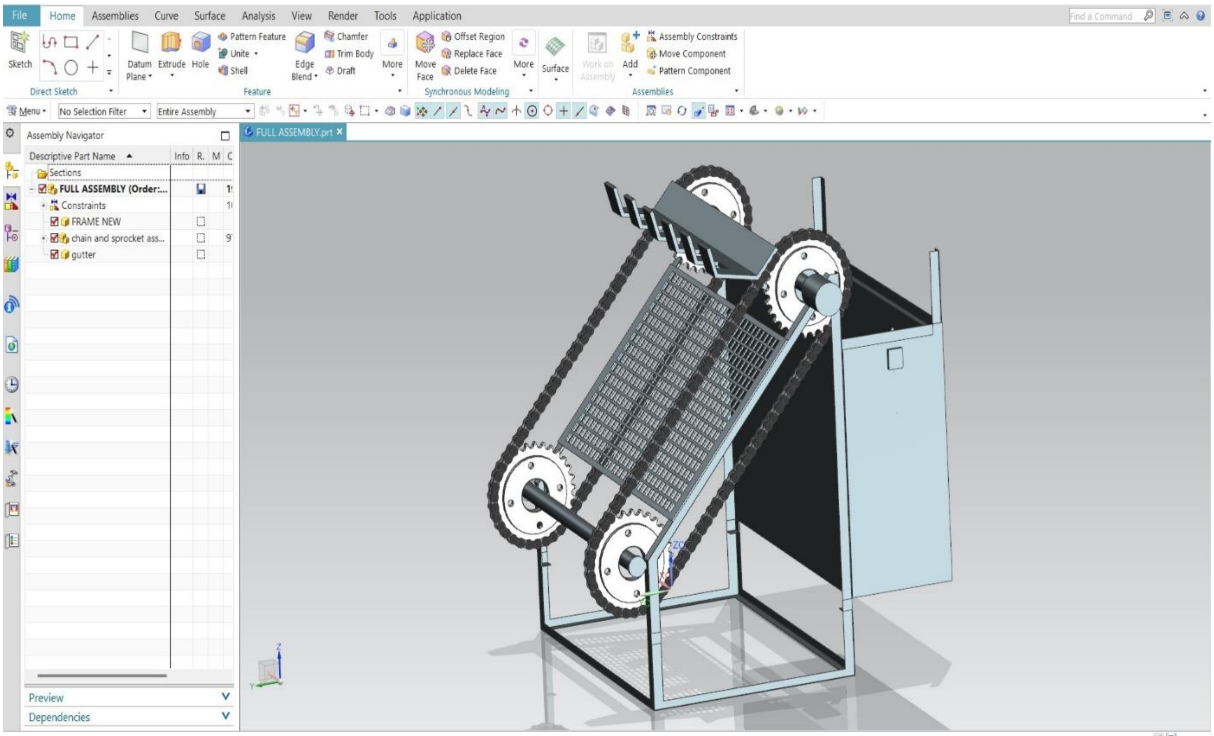

Fig 4.18 Assembly model of automated drain cleaning system

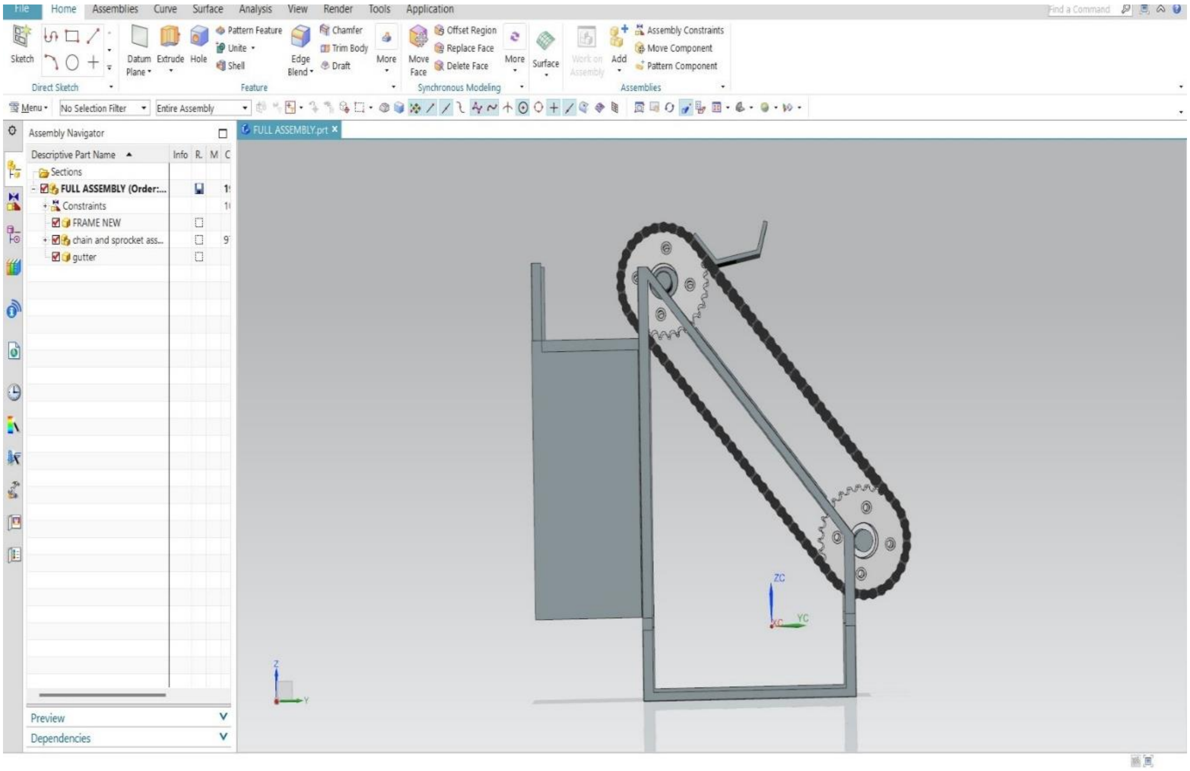

Fig 4.19 Assembly side view

The 3D model is completed using solid works which contains of sprocket, bin, chain, base frame, motor, lifted mounts ,shaft, transmitter. This model is further useful to perform analysis by importing the model into Ansys workbench.

4.4 Analysis of automated drain cleaning system

4.4.1 Introduction to finite element analysis:

The finite element system(FEM) is a largely protean numerical analysis tool that can give approximate results to a wide range of engineering problems. Although it was originally developed to study stresses in complex airframe structures, FEM has ago been extended and applied to the broader field of continuum mechanics. One of the crucial advantages of FEM is its diversity and inflexibility as an analysis tool. It can be used to model a wide range of physical marvels, including fluid dynamics, heat transfer, and electromagnetics. This has led to a significant increase in the use of FEM in both academic exploration and artificial operations. The wide relinquishment of FEM can also be attributed to advances in computer technology and computer- backed design(CAD) systems. These advances have made it possible to model and dissect decreasingly complex engineering problems with relative ease.

4.4.2 Basic Steps in the Finite Element Analysis:

Create and discretize the solution domain into finite elements i.e.subdivide the real continuum into nodes and elements.

Assume a shape function to represent the physical behavior of an element;that is an approximate continuous function is assumed to represent the solution of an element.

1. Develop equations for all the elements in the mesh.
2. These generally take form [K]{U} = {F}

Where '[K]' is a square matrix, known as stiffness matrix

'{U}' is the vector of (unknown) nodal displacements or temperature

'{F}' is the vector of applied nodal forces

3. Assemble the elemental equations to obtain the equations of the whole problem.
4. Construct the global stiffness matrix.
5. Apply boundary conditions, initial conditions, and loading.

Solution Phase:

Solve a set of linear or nonlinear algebraic equations simultaneously to obtain nodal results of primary degrees of freedom or unknowns, such as displacement values at different nodes in structural problem or temperature values at different nodes in heat transfer problem.

4.4.3 Introduction to ANSYS Workbench:

ANSYS Workbench is the framework upon which the industry's broadest suite of advanced engineering simulation technology is built. An innovative project schematic view ties together the entire simulation process, guiding the user every step of the way. Even complex multi physics analysis can be performed with drag-and-drop simplicity

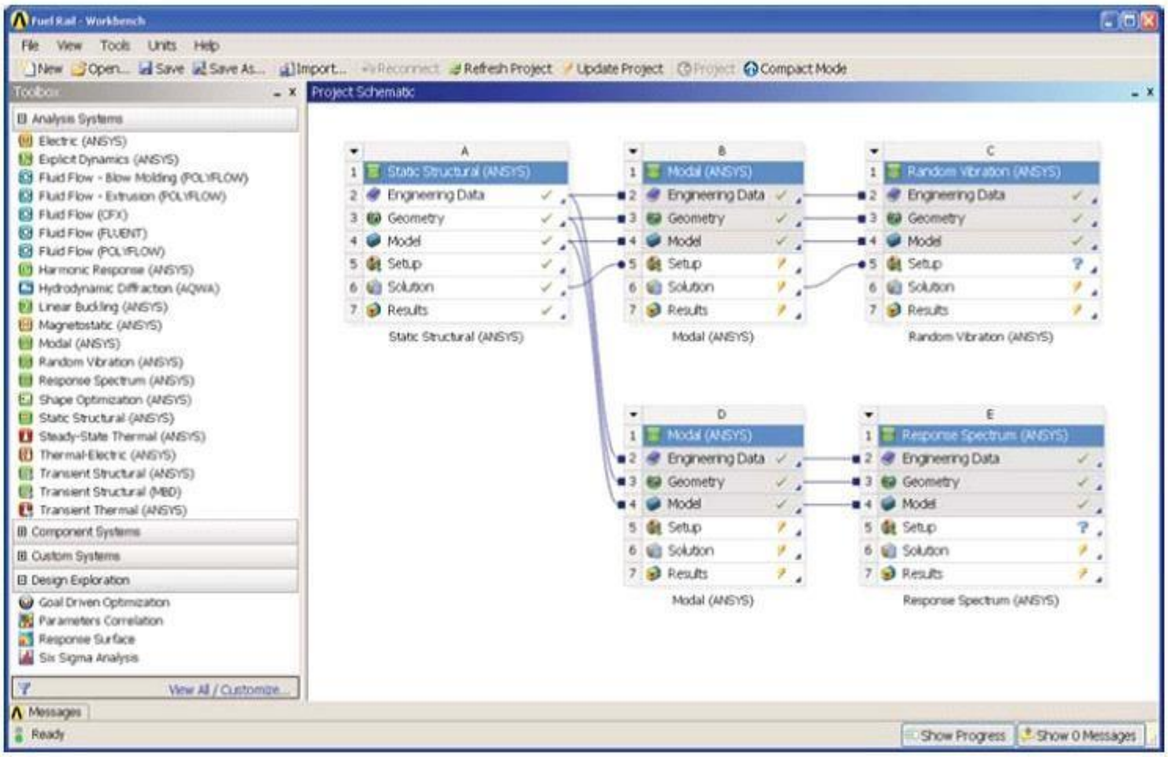

Fig 4.20 Workbench 21 R2 Interface

The ANSYS Workbench serves as a powerful platform that enables engineers to conduct advanced engineering simulations across a range of industries. This framework incorporates a project schematic view that provides a comprehensive and intuitive approach to guiding users through the simulation process, making it easy to navigate through complex multi-physics analyses. With its drag-and-drop functionality, users can quickly and efficiently perform simulations on a wide range of systems and structures. Additionally, ANSYS Workbench offers a suite of advanced simulation technologies that are continually evolving and expanding to meet the needs of the engineering community. As a result, ANSYS Workbench is widely regarded as one of the most versatile and powerful simulation frameworks available in the industry today.

4.4.4 ANSYS Workbench Features:

The ANSYS Workbench platform provides a seamless connection between different analysis types, allowing for efficient and accurate simulations of complex engineering problems. With the ability to automatically share geometry and transfer loads, ANSYS

Workbench reduces the need for manual data entry and storage, saving time and minimizing errors. The interface of ANSYS Workbench is designed to be user-friendly and intuitive. The toolbox and project schematic provide a clear overview of the simulation project, with easy access to frequently used functions and capabilities. The project schematic view allows for easy management of the project, with visible data relationships and engineering intent, making it easy to keep track of the entire simulation process.

Additionally, ANSYS Workbench allows for context menus accessible via a right-click, providing further capabilities to modify and add to projects. The entire process is persistent, allowing for efficient and effective simulation results.

Overall, ANSYS Workbench provides a powerful platform for advanced engineering simulation technology, with a user-friendly interface and efficient simulation process.

4.4.5 Structural Analysis:

Structural analysis is probably the most common application of the finite element method. The term Structural or structure implies not only civil engineering structures such as bridges and buildings, but also naval, aeronautical, and mechanical structures such as ship hulls, aircraft bodies, and machine housings, as well as mechanical components such as pistons, machine parts, and tools.

1)Static Analysis:

Static analysis is a type of software testing that examines the code without actually executing it. It is an effective way to identify potential bugs and security vulnerabilities before the code is deployed. Static analysis tools can help developers identify coding errors, poor programming practices, and adherence to coding standards..

2)Explicit Dynamics Analysis:

Explicit dynamic analysis is a type of finite element analysis that is used to study the response of structures subjected to high-velocity impact or transient dynamic loads. In this type of analysis, the equations of motion are solved explicitly at each time step to determine the response of the structure.

4.4.6 PROCEDURE FOR PERFORMING STATIC STRUCTURAL ANALYSIS:

STEP 1: SELECTION OF ANALYSIS FEATURE

Open Ansys workbench and then select static structural analysis from left side tool bar.

STEP 2: ENGINEERING DATA

The data to be calculated is to be submitted in this module. Properties such asyield strength, young's modulus, Poisson's ratio, F.O.S are to be provided.

STEP 3: INSERTION OF GEOMETRY

Right click on the geometry and then click on Import Geometry. Then close the present tab and again right click on the geometry then click on the Modify Designer Tool.

STEP 4: MODEL

Right click on the model. To load the model in to work bench .

STEP 5: MESHING

Click on mesh option and insert patch conforming method and select meshingmethod as Tetrahedrons**.** Select sizing and set span angle center of mesh as fine.

Now right click on mesh and click on generate mesh. Then Tetrahedrons mesh is generated over the model

STEP 6: INSERTION OF SUPPORTS AND FORCES

Right click on Static structural icon. Click on INSERT. Then select fixed support and click on apply. Again, right click on Static structural icon. Click on INSERT**.** Then select force and click on apply. Then the force is defined by the component i.e., in which direction the force is to be applied.

STEP 7: ANALYSIS

Right click on Solution icon. Click on INSERT. Then select Equivalent stress, Max. Shear stress, Safety factor, Fatigue life and click on apply. Now right clickon Solution icon and click on Solve.

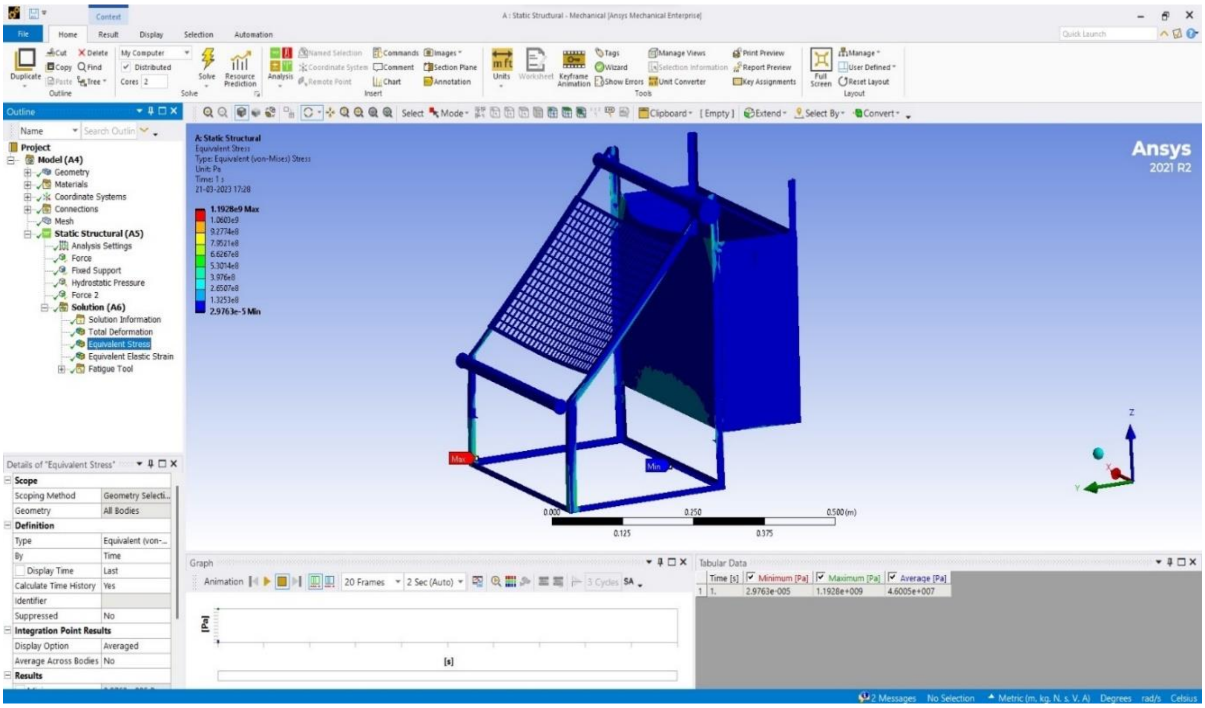

Fig 4.21 Details of Equivalent Stress

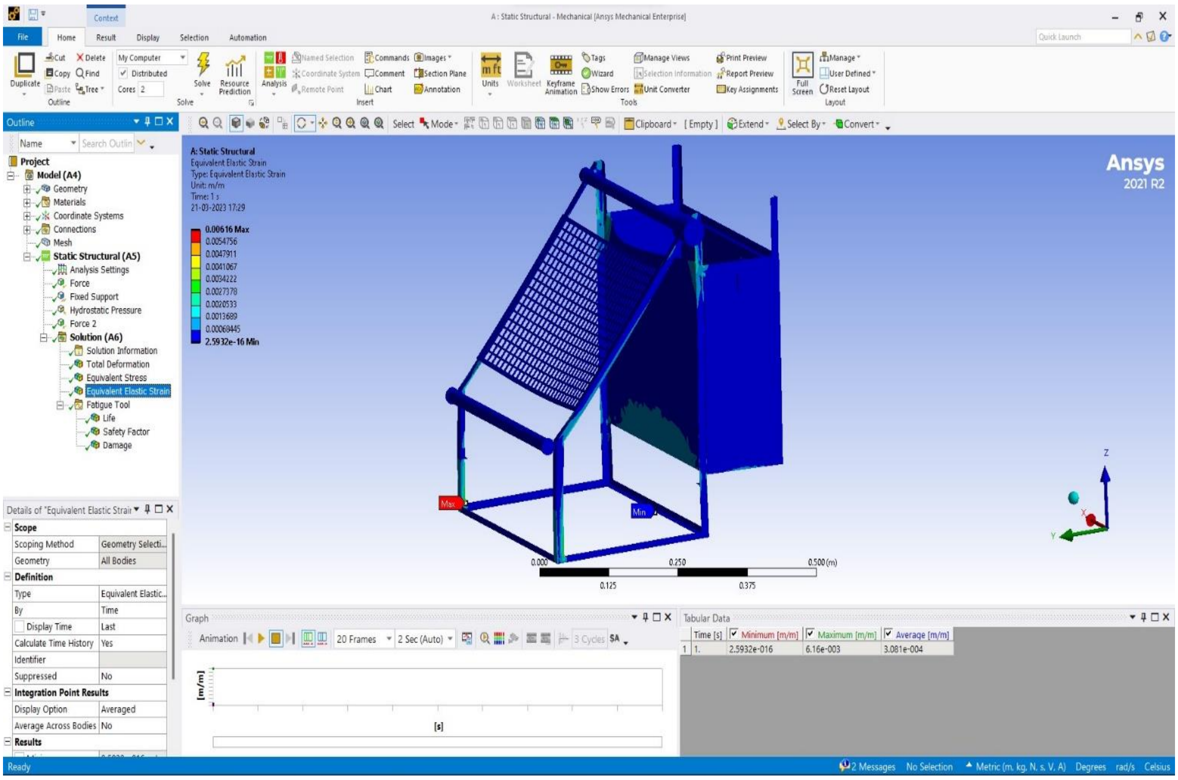

Fig 4.22 Details of Equivalent Elastic Stress

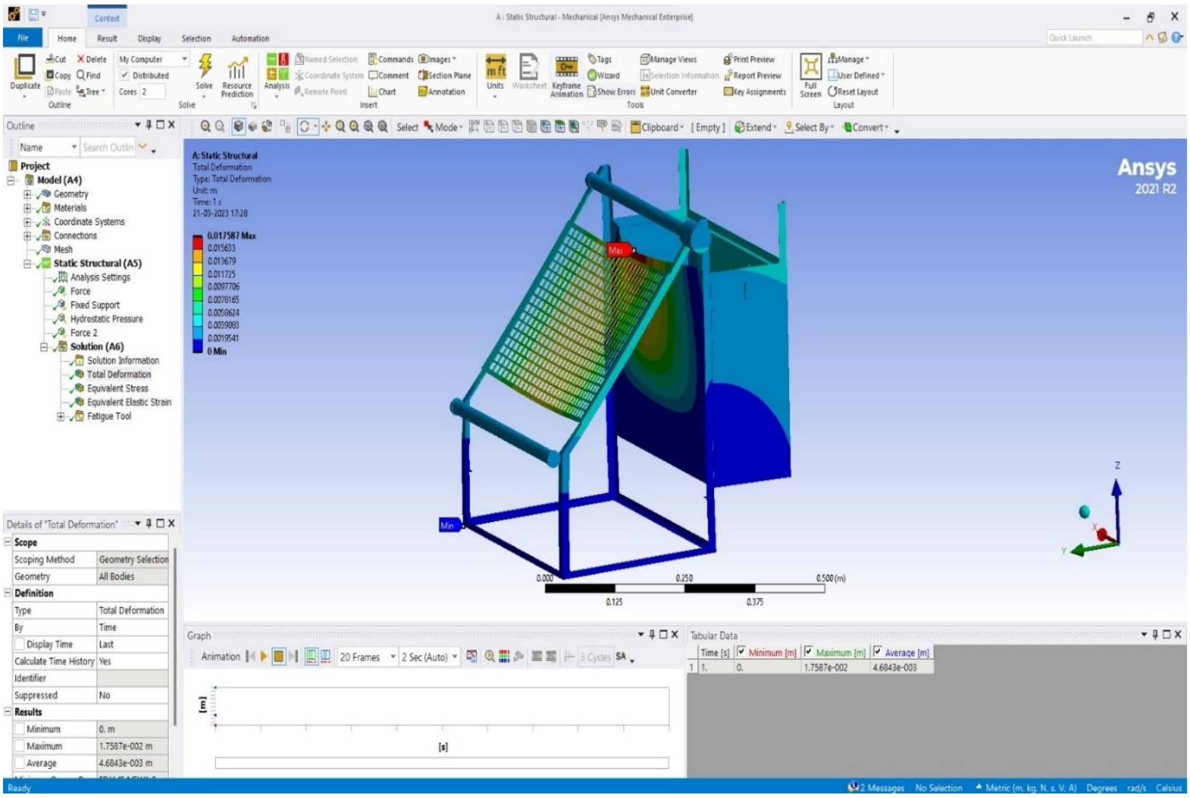

Fig 4.23 Total Deformation

4.4.7 DYNAMIC ANALYSIS

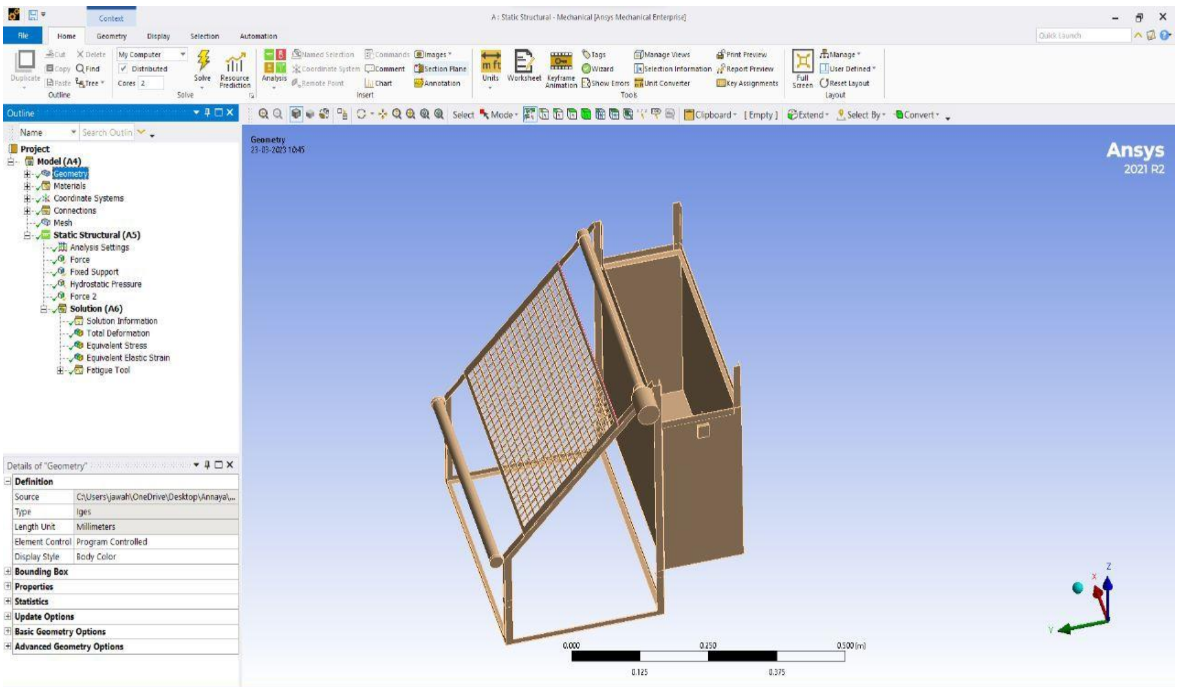

Fig 4.24 Geometry imported

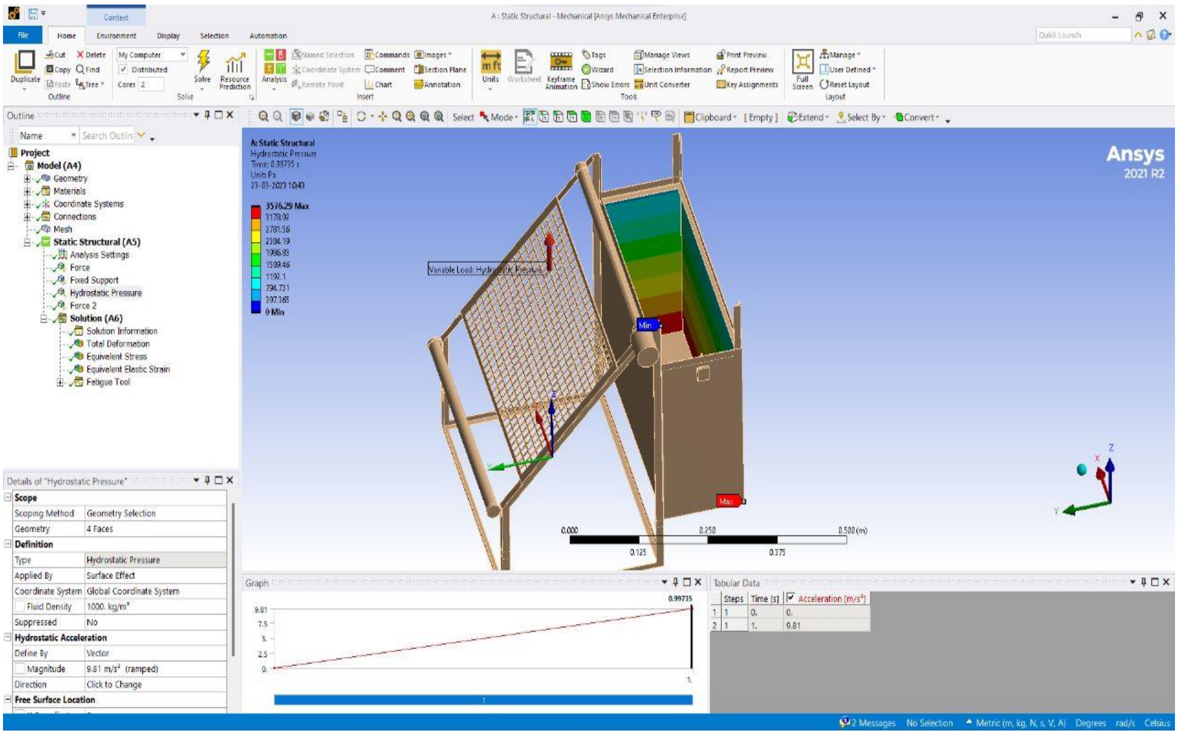

Fig 4.25 Hydrostatic pressure

The image displays the results of a dynamic analysis performed in the ANSYS software, which simulates the behavior of a structure under hydrostatic pressure. The color-coded contour plot shows the deformation of the structure, with red indicating the highest deformation and blue indicating the lowest deformation. The applied pressure is shown as a blue arrow on the right side of the image.

The stress and strain distribution in the structure is shown through graphs that indicate the maximum values of both parameters. The stress graph indicates that the maximum stress values are highest near the center of the structure, where the hydrostatic pressure is most significant. Similarly, the strain graph shows that the maximum strain values are also highest in the center of the structure.

Dynamic analysis in ANSYS allows engineers to simulate the behavior of structures under changing pressure conditions, providing valuable insights into their structural integrity and durability. This information is critical for the design and optimization of structures that can withstand expected loading conditions, ensuring they perform their intended function safely and efficiently.

The results of this dynamic analysis can be used to identify areas of the structure that experience the most significant stress and strain under hydrostatic pressure. Based on this information, engineers can make informed design decisions, such as adjusting the material properties or changing the structural design, to ensure that the structure can withstand the expected loading conditions and perform its intended function safely and efficiently

4.4.8 FATIGUE ANALYSIS

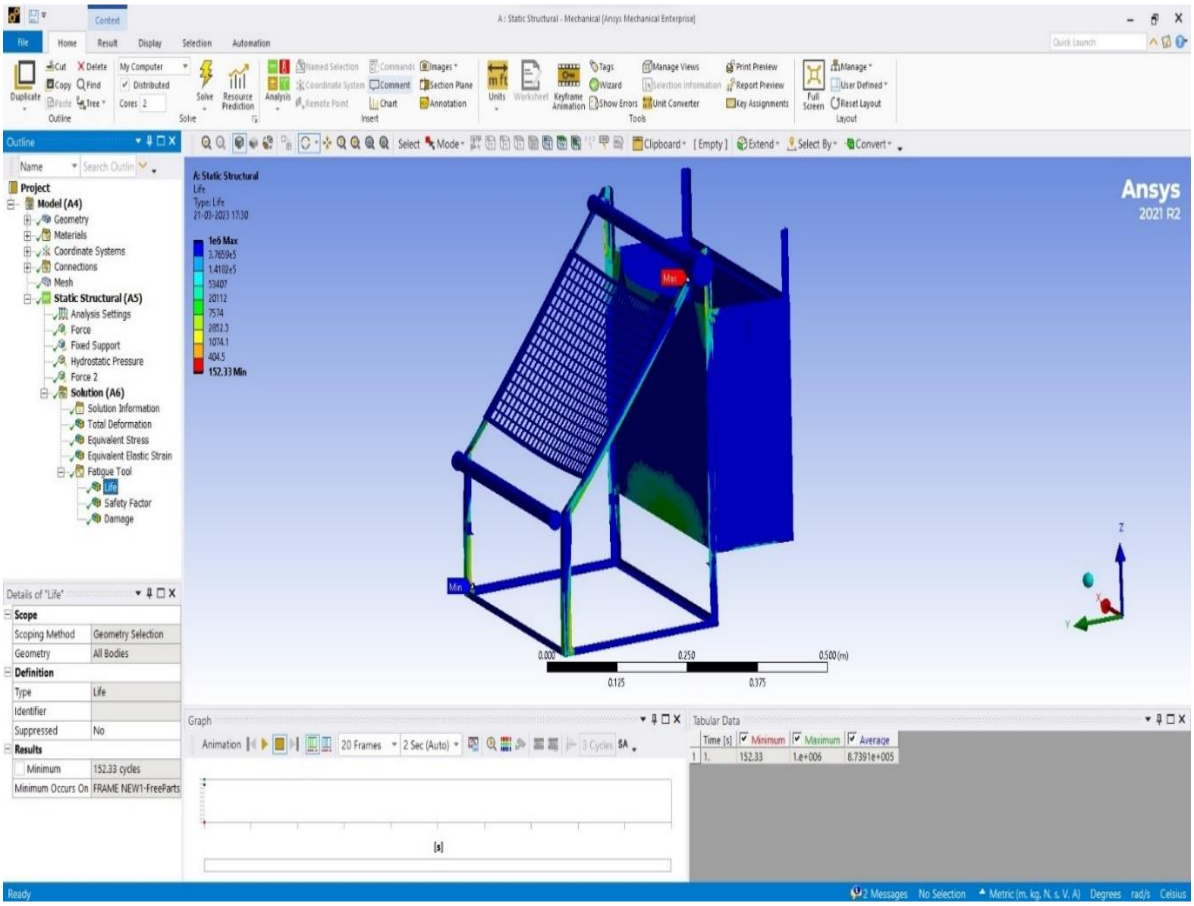

Fig 4.26 Details of system Life

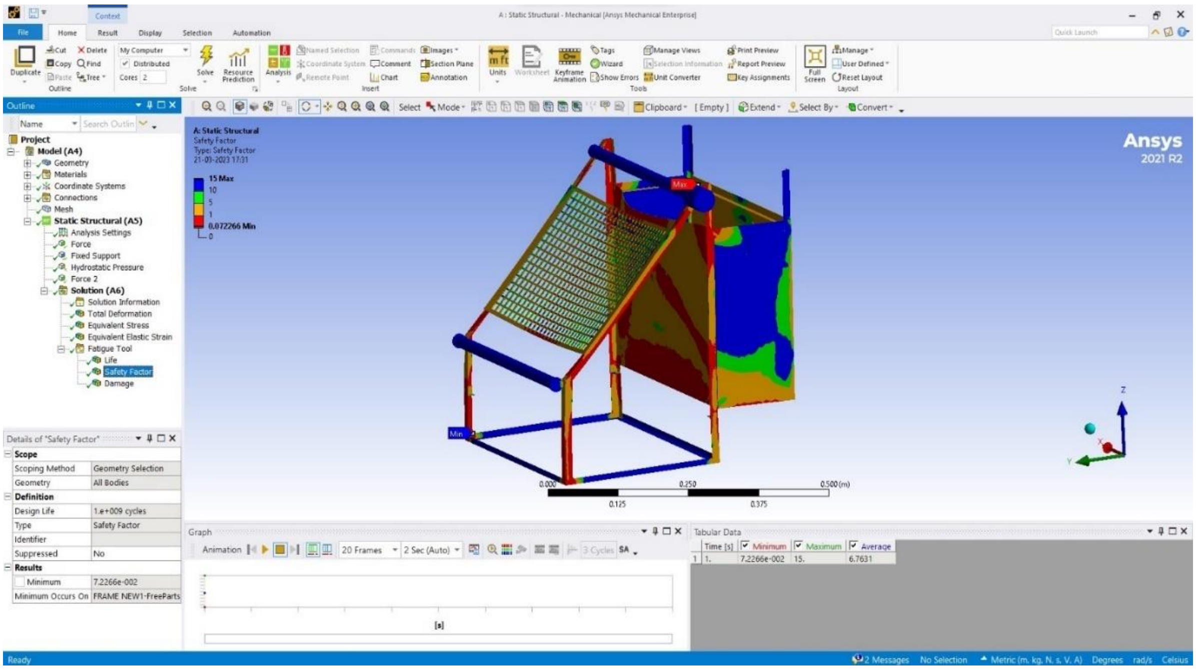

Fig 4.27 Details of safety factor for system

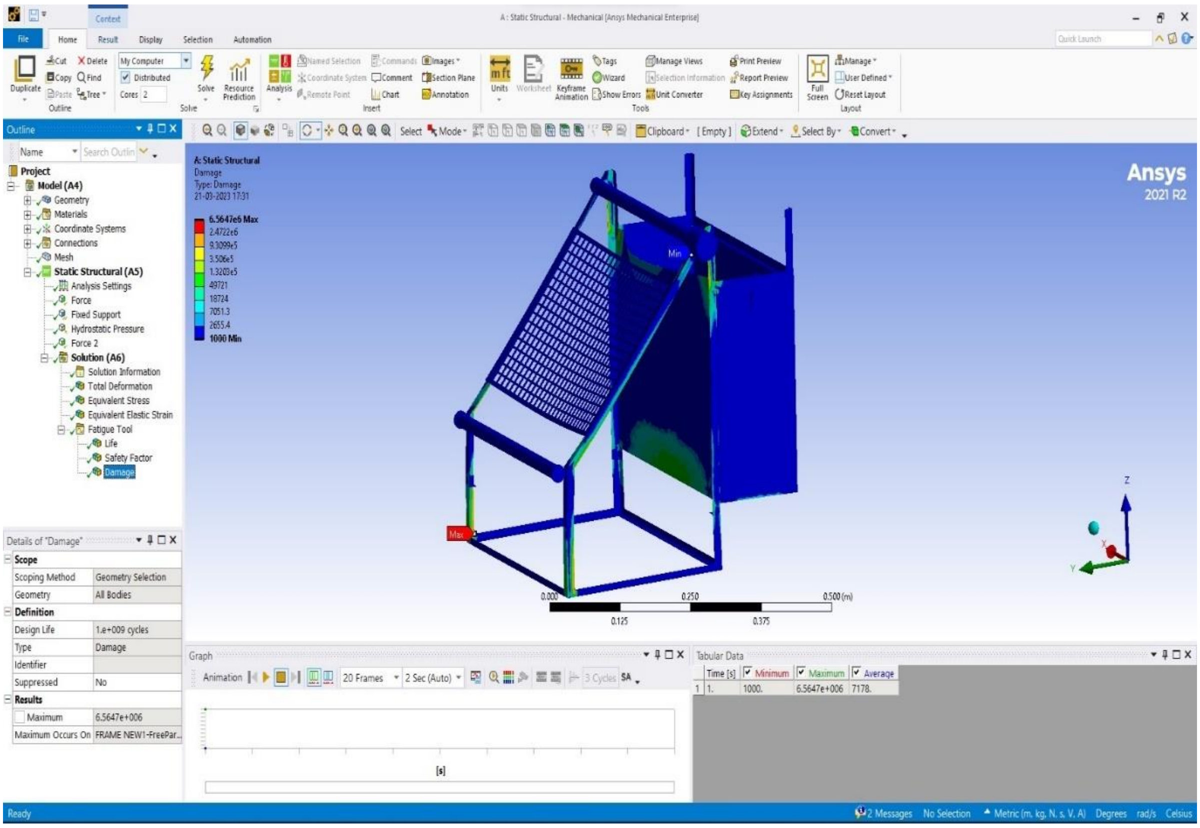

Fig 4.28 Details of Damage occurs in system

FATIGUE GRAPH

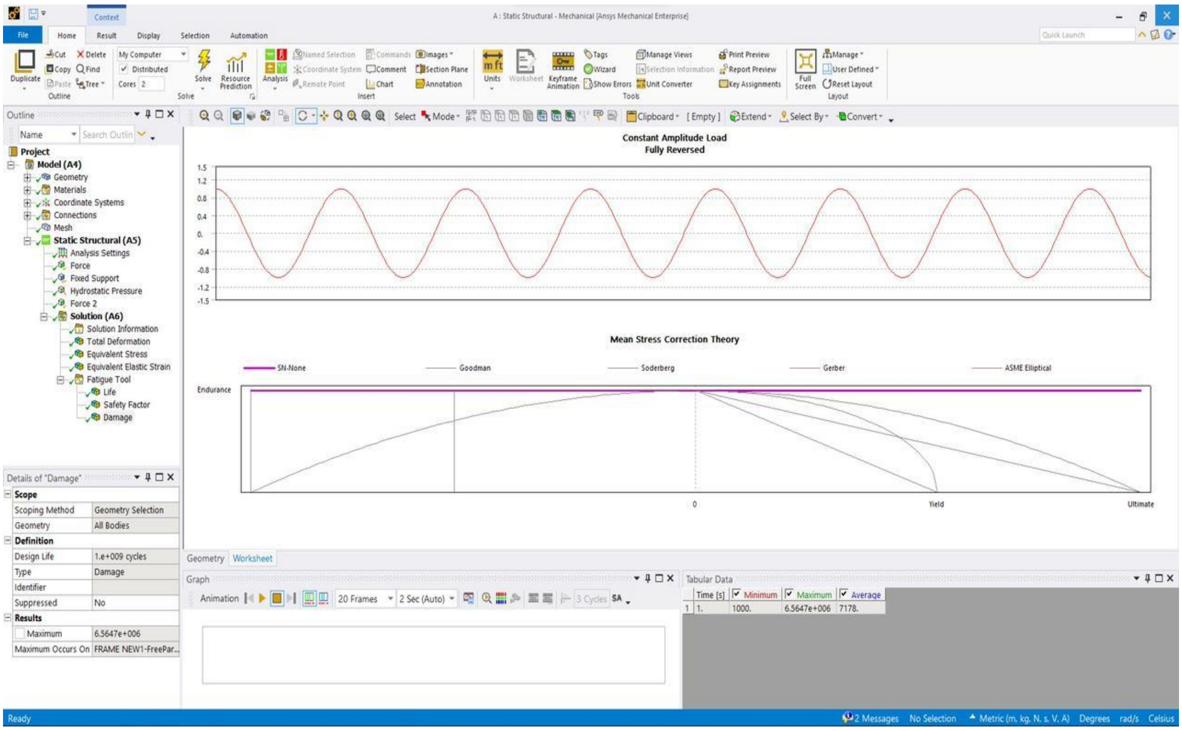

Fig 4.29 Graph on Maximum Stress Correction Theory

The graph represents the S-N (stress versus number of cycles) curve for a material subjected to a fully reversed constant amplitude load. The y-axis values on the graph represent the stress amplitude values ranging from +1.5 to -1.5, with 0 in the middle. The stress amplitude is the difference between the maximum and minimum stress values during one cycle of loading.

The x-axis of the graph represents the number of cycles to failure. The S-N curve typically shows a gradual decrease in stress amplitude for a given number of cycles, indicating the material's progressive damage and eventual failure.

The graph also includes a line indicating the endurance limit obtained from mean stress correction theory. The endurance limit is the stress level below which the material can theoretically endure an infinite number of cycles without failure. The mean stress correction theory accounts for the influence of the mean stress on the material's endurance limit.

The point at which the S-N curve intersects with the endurance limit line is called the fatigue limit, below which the material can endure an infinite number of cycles without failure, even at stress levels lower than the endurance limit. In some cases, the fatigue limit may be zero, indicating that the material will fail after only a few cycles at any stress level.

In summary, the graph represents the S-N curve for a material subjected to a fully reversed constant amplitude load and shows the material's endurance limit obtained from mean stress correction theory. The graph provides valuable information about the material's fatigue behavior and can be used to predict its fatigue life under various loading conditions

4.5 Wireless Communication

The wireless transmitter and receiver modules work at 315 Mhz. They can easily fit into a breadboard and work well with microcontrollers to create a quite simple wireless data link. With one pair of transmitter and receiver, the modules will only work communicating data one-way; however, you would need two pairs (of different frequencies) to function as a transmitter/receiver pair.

4.5.1 Receiver Module Specifications

- Product Model − MX-05V
- Operating voltage − DC5V
- Quiescent Current − 4mA
- Receiving frequency − 315Mhz
- Receiver sensitivity − -105DB
- Size − 30 * 14 * 7mm

4.5.2 Transmitter Module Specifications

- Product Model − MX-FS-03V
- Launch distance − 20-200 meters (different voltage, different results)
- Operating voltage − 3.5-12V
- Dimensions − 19 * 19mm

- Operating mode – AM
- Transfer rate − 4KB / S
- Transmitting power − 10mW
- Transmitting frequency − 315Mhz
- An external antenna − 25cm ordinary multi-core or single-core line
- Pinout from left → right − (DATA; V_{CC}; GND)

4.5.3 Components Required

- 2 × Arduino UNO board
- 1 × Rf link transmitter
- 1 × Rf link receiver

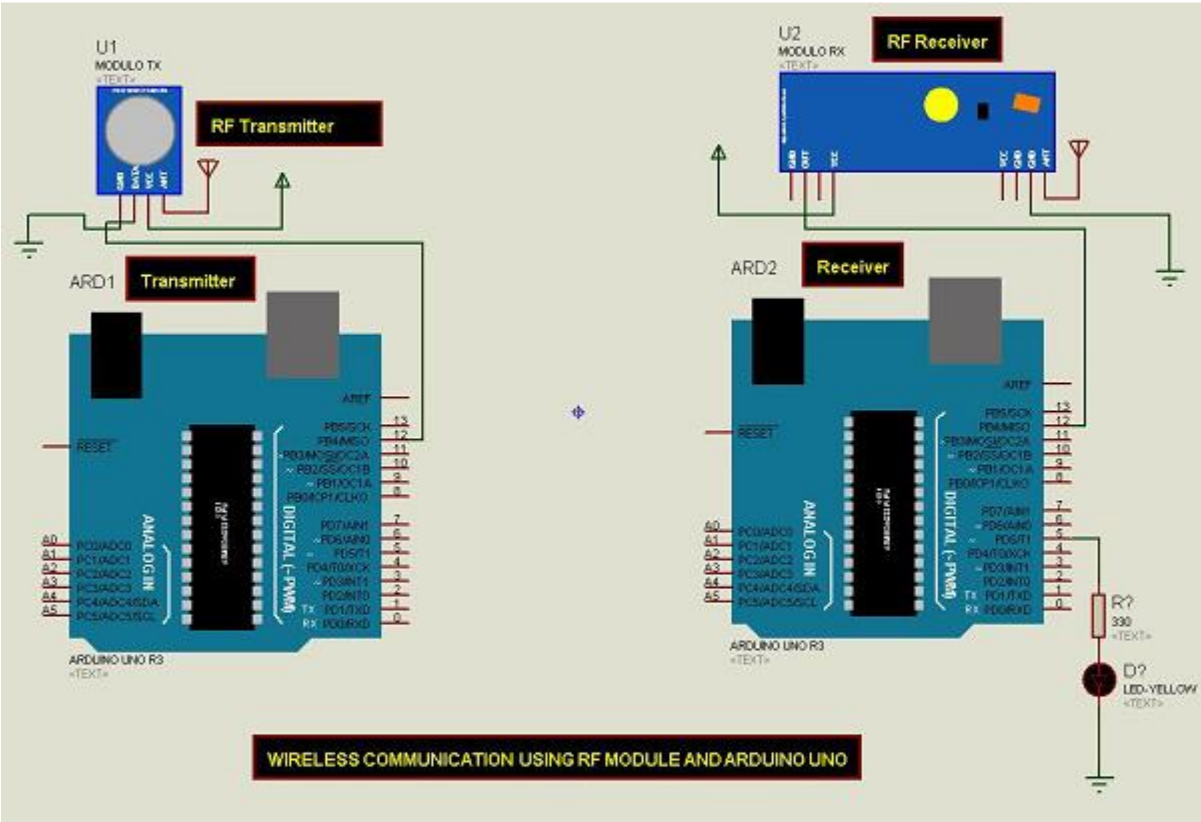

Fig 4.30 Wireless communication using Rf module and Arduino.

Arduino Code for Transmitter

This is a simple code. First, it will send character '1' and after two seconds it will send character '0' and so on.

Certain number will be fixed and kept until it reaches the maximum level of the bin

Arduino Code for Receiver

The LED connected to pin number 5 on the Arduino board is turned ON when character '1' is received to communicate that solid waste reached its level and turned OFF when character '0' received that is when solid waste is not up to the level in the bin.

The RF link transmitter and receiver modules operate at 315 MHz and can be easily integrated into a breadboard, making them a great choice for creating a wireless data link with microcontrollers. However, it's important to note that with only one pair of transmitter and receiver, the modules will only work for one-way communication. To establish a two-way communication link, you would need two pairs of RF modules operating at different frequencies.

CHAPTER 5

RESULTS AND DISCUSSIONS

Table 5.1 Static structural analysis

MECHANICAL VALUES	MINIMUM	MAXIMUM	AVERAGE
EQUIVALENT STRESS	2.9763e-005	1.1928e+009	4.6005e+007
EQUIVALENT ELASTIC STRAIN	2.5932e-016	6.16e-003	3.0813-004
TOTAL DEFORMATION	0	1.7587e-002	4.6843e-003

As we can see from above tabular form, we performed a Static structural analysis on structural steel. In static structural analysis, we got results of Equivalent stress, Equivalent elastic strain, Total deformation.

The analysis results are presented below:

- Equivalent Stress: The equivalent stress is a measure of the stress level that a simple tension or compression would produce. The minimum value of the equivalent stress is 2.9763e-005 and the maximum value is 1.1928e+009. The average equivalent stress is 4.6005e+007.
- Equivalent Elastic Strain: The equivalent elastic strain measures how much the material deforms under stress. The minimum value of the equivalent elastic strain is 2.5932e-016 and the maximum value is 6.16e-003. The average value of the equivalent elastic strain is 3.0813-004.
- Total Deformation: The total deformation represents the overall deformation of the structure. The minimum value of total deformation is 0 and the maximum value is 1.7587e-002. The average value of total deformation is 4.6843e-003.

The analysis results indicate that the material undergoes a wide range of stresses and strains under the given loading conditions. The minimum value of the equivalent stress is very low, indicating that the material can withstand small stresses without significant deformation. However, the maximum value of the equivalent stress is very high, indicating that the material may experience significant deformation or even failure under high-stress conditions.

The equivalent elastic strain results suggest that the material is relatively elastic, meaning that it can return to its original shape after being subjected to stresses up to a certain limit. However, the maximum value of the equivalent elastic strain indicates that the material can experience significant permanent deformation under high-stress conditions.

The total deformation results indicate that the material undergoes a significant amount of deformation under the given loading conditions. The maximum value of the total deformation indicates that the material can experience significant deformation or even failure under high-stress conditions.

Conclusion 1:

In conclusion, the results of the static structural analysis provide important information about the structural integrity of the material and can be used to optimize its design or to assess its performance under various loading conditions. The analysis results suggest that the material can withstand small stresses without significant deformation but may experience significant deformation or even failure under high-stress conditions. The results of this analysis can be used to optimize the design of the material to improve its performance under various loading conditions.

Table 5.2 Fatigue analysis

MECHANICAL VALUES	MINIMUM	MAXIMUM	AVERAGE
DAMAGE	1000	6.5647e+006	7178
SAFETY FACTOR	7.2266e-002	15	6.7631
LIFE	152.33	1.e+006	8.7391e+00

The fatigue analysis results are presented below:

- Damage: The damage refers to the extent of harm caused to the material due to cyclic loading. The minimum damage is 1000, and the maximum damage is 6.5647e+006.
- Safety Factor: The safety factor represents the ratio of the material's strength to the applied load. The minimum safety factor is 7.2266e-002, and the maximum safety factor is 15. The average safety factor is 6.7631.
- Life: The life of the material refers to the number of cycles it can endure before failure. The minimum life is 152.33 cycles, the maximum life is 1.e+006 cycles, and the average life is 8.7391e+00 cycles.

The fatigue analysis results indicate that the material undergoes significant damage due to cyclic loading. The minimum damage value of 1000 suggests that even under relatively low-stress conditions, the material undergoes damage. The maximum damage value of 6.5647e+006 suggests that the material can experience severe damage under high-stress conditions.

The safety factor results indicate that the material can withstand cyclic loading up to a certain limit. The minimum safety factor value of 7.2266e-002 suggests that the material is not very durable under high-stress conditions. The maximum safety factor value of 15 suggests that the material can withstand significant cyclic loading before failure.

The life results indicate that the material can endure a limited number of cycles before failure. The minimum life value of 152.33 cycles suggests that the material is not very durable under cyclic loading. The maximum life value of 1.e+006 cycles suggests that the material can withstand significant cyclic loading before failure.

Conclusion 2:

In conclusion, the results of the fatigue analysis provide important information about the material's durability and can be used to make informed decisions about its use in various applications. The analysis results suggest that the material undergoes significant damage due to cyclic loading and can endure a limited number of cycles before failure. The results of this analysis can be used to optimize the design of the material and to determine the appropriate operating conditions to ensure its durability and longevity.

Table 5.3 Symmetric deformable for Set Id 1

Contact stiffness factor	10.00
Default penetration tolerance factor	FTOLN 0.10000
Resulting penetration tolerance	0.22707E-03
Average contact surface length	0.67278E-02
Default Max. Frictional stress	0.10000E+21
Default pinball region	0.25000
Resulting pinball region	0.56768E-03

Table 5.4 Symmetric deformable for Set Id 2

Contact stiffness factor	10.00
Default penetration tolerance factor	FTOLN 0.10000
Resulting penetration tolerance	0.73495E-04
Average contact surface length	0.99367E-03
Default Max. Frictional stress	0.10000E+21
Default pinball region	0.25000
Resulting pinball region	0.18374E-03

Table 5.5 Symmetric deformable for Set Id 3

Contact stiffness factor	10.00
Default penetration tolerance factor	FTOLN 0.10000
Resulting penetration tolerance	0.15523E-03
Average contact surface length	0.30762E-02
Default Max. Frictional stress	0.10000E+21
Default pinball region	0.25000
Resulting pinball region	0.38806E-03

Table 5.6 Symmetric deformable for Set Id 4

Contact stiffness factor	10.00
Default penetration tolerance factor	FTOLN 0.10000
Resulting penetration tolerance	0.73462E-04
Average contact surface length	0.99584E-03
Default Max. Frictional stress	0.10000E+21
Default pinball region	0.25000
Resulting pinball region	0.18365E-03

Table 5.7 Symmetric deformable for Set Id 5

Contact stiffness factor	10.00
Default penetration tolerance factor	FTOLN 0.10000
Resulting penetration tolerance	0.73499E-04
Average contact surface length	0.99348E-03
Default Max. Frictional stress	0.10000E+21
Default pinball region	0.25000
Resulting pinball region	0.18375E-03

TOTAL MASS = 10kgs

The mass principal axes coincide with B Cartesian axes

CENTER OF MASS (X,Y,Z)= 0.16842E-01 -0.10392 0.20004

TOTAL INERTIA ABOUT CENTER OF MASS

0.31285	-0.21489E-02	0.24097E-01
-0.21489E-02	0.33383	0.21454E-01
0.24097E-01	0.21454E-01	0.36878

PRINCIPAL INERTIAS = 0.30072 0.32956 0.38519

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN

(0.858, 0.317,-0.404) (-0.427, 0.878,-0.218) (0.285, 0.359, 0.889)

MASS SUMMARY BY ELEMENT TYPE - MASS

1 7.49136

2 0.139291E-02

3 0.717360E-03

Range of element maximum matrix in global coordinates

Maximum = 2.520662221E+10 at element 142251.

Minimum = 94388675.8 at element 74264.

Mesh Statistics

Number of elements: 178349

Number of nodes:315384

Element load balance ratio =1.053

CHAPTER 6

CONCLUSION AND FUTURE SCOPE

6.1 CONCLUSION

In conclusion, the development of an automated drain cleaning system has the potential to revolutionize the maintenance of drainage systems, both in residential and industrial settings. The proposed system offers a cost-effective and efficient solution to the time-consuming and labor-intensive task of drain cleaning. The automated nature of the system ensures that the process is fast, efficient, and does not require human intervention.

The system's design is adaptable, allowing for customization to fit different drain types and sizes. This adaptability makes it a versatile solution that can be implemented in various settings. The results of the feasibility study indicate that the system is effective in removing clogs and is reliable in operation. The system's potential to reduce maintenance costs and increase efficiency makes it a viable solution for drain cleaning. So this device whose primary aim is to remove solid wastes from the drainage is designed to carry more load and to withstand optimum conditions with more durability and with advanced technology in order to ensure that there is no clotting of drainage water i.e. to avoid gutter jamming issues it was designed successfully. It lets the fluid to flow through it and it catches the large solid waste and accumulates it.

6.2 FUTURE SCOPE

In terms of future scope, there are several areas where further research and development can be done to improve the performance of these systems.

Firstly, the development of sensors and algorithms that can accurately detect and locate blockages within the drainage system can help to optimize the cleaning process and reduce the time and effort required to clean the drains.

Secondly, the use of advanced materials and coatings for the cleaning components of the system can improve their durability and longevity, reducing the need for frequent replacements.

Thirdly, incorporating remote monitoring and control features in the system can provide real-time feedback on the status of the cleaning process, enabling quick and efficient responses to any issues that may arise. Finally, the integration of machine learning and artificial intelligence technologies can help to optimize the performance of the system and enable it to adapt to changing conditions, further improving its efficiency and effectiveness. This Analysis is focused only on static structural, dynamic loading . So, the further study may include thermal analysis and working conditions of the system. As it will be placed in drain, one can use CFD analysis to check the flow of water speed and to improve the thermal behavior of base frame.

We can apply this project in remote and slum areas with effectiveness. Since the drains are linked with hygiene and in slum areas this is the major problem and we can apply this project in those areas and can safeguard the health of the people.

Government can further implement and develop this system in regional municipal offices under a scheme for the welfare of people

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Web Resources

A) http://www.google.com/

B) http://www.engineersedge.com/

C) http://www.efunda.com/

D) http://www.mechanicalengineeringblog.com/

E) www.wikipedia.com