International Journal of Engineering and Science Invention (IJESI)
ISSN (Online): 2319-6734, ISSN (Print): 2319-6726
www.ijesi.org ||Volume 12 Issue 12 December 2023 || PP 32-58

Design and Development and Analysis of Filament Winding machine forComposite materials

Prajwalgouda Patil (BE MECHANICAL)
KLS GOGTE INSTITUTE OF TECHNOLOGY, BELAGAVI.

ABSTRACT
In general, the composite pipes are fabricated using glass fiber and polyester resin matrix by hand lay-up and also by 2-axis filament winding machine. In this work, a filament winding machine was designed and developed for the fabrication of pipes and round shape specimens. A lathe-type machine and a wet winding method were used in the design of the machine. It provides a capability for producing pipe specimens with an internal diameter up to 100 mm and lengths up to 1000 mm. The range of the winding angle, or the fiber orientation angle, starts from 20to 90depending on the mandrel diameter used. Mandrel speed is kept constant as 13.6 revolutions per minute (rpm) while the speed of screw of delivery unit varies from 0 rpm to a maximum of 250 rpm. In the filament winding process used, a single glass roving is drawn through a bath of pre-catalyzed resin which is mounted on the lead screw by the rotating mandrel. A control unit was used to control the whole process and achieve regular winding and good surface finish. Tube samples and other circular specimens of different dimensions were produced using this machine for the different mechanical tests and applications.

Date of Submission: 08-12-2023 Date of Acceptance: 22-12-2023

AKNOWLEDGEMENT
We take this opportunity to express our sincere gratitude to the people who have been helpful in the successful completion of our project. We would like to show our greatest appreciation toour professors and staff members at the Department of Mechanical Engineering.
We are indebted to our guide Prof. Mahesh Kori for his valuable suggestions and inspiring guidance throughout the course of this project. We would also like to thank Dr. H. B. Kulkarni,Professor & Head Dept. of Mechanical Engineering, Dr.D.A,Kulkarni, Principal of KLS GogteInstitute of Technology, for providing valuable guidance and facilities to carry out the work. We are grateful to support staff of mechanical department, helping us in several ways throughout our project.
We are grateful to Mr.Shravankumar,(La Dassault Sytems) for his support in several ways to analyse and solve the problem throughout our project.
We would like to thank everybody who directly or indirectly helped us carry out this project successfully.

I. INTRODUCTION.

Filament winding has emerged as the primary process for composite cylindrical structures fabrication at low cost. In this process, composite layers are successively wound on a rotatingmandrel, as presented in Fig. 1. The layers maybe wrapped at different angles varying fromhoop layers, which are perpendicularto the cylinder axis, to helical layers which are at an angleto the cylinder axis. Theconstruction of composite cylinder by filament winding consists ofthree major steps, the first is the design, which includes the selection of materials, geometry, and fiber orientations while the second is fiber placement, the mechanical means by which the fibers are placed in their proper positions. Finally, the third is the selection and control of conditions which must be maintained during the manufacturing process.

A process for fabricating a composite structure in which continuous reinforcements (filament, wire, yarn, tape, or other), either previously impregnatedwith a matrix material orimpregnated during the winding, are placed over a rotating and removable form or mandrel in a prescribed way to meet certain stressconditions. The reinforced fibers are usually made of glass, Kevlar or carbon. Owing to simplicity of process, the hardware configuration is quite standard, andgenerally involves two main sub-systems; the rotary assembly and the delivery system. The rotary assembly consists of two structural blocks one fixed and the other linearly movable unit in which a 2-axis mechanically driven mandrel is mounted ontoits holders. On the fixed end, the holder is connected to a rotating shaft, which is coupled toeither a gear or a chain or belt reduction system, or directly to the motor unit. Generally, anAC or servo-motor is used because of itsgreater torque capabilities and accuracy when operating under conditions of heavyloading. For delivery system, rolls of continuous fibers are fed into a resin bath which is mounted onto the carriage rails that are commonly placed overhead to provide greater workroom. Generally, the shape is a surface of revolution and mayor may not include end closures. When the required number of layers is applied, the wound form is cured and the mandrel removed. The material properties in eachlayer are constant but may vary from layer to layer. The mandrel is represented bya hollow cylinder with uniform effective wall thickness. The mandrel and the cylinder are of equal length and are asymmetrical, so that neither the geometry nor the properties vary in the circumferential direction. Filament winding is defined as a technique which ‘‘produces highstrength and lightweight products; consists basically of two ingredients namely, a filament or tape type reinforcement and a matrix or resin’’. The concept of filament winding process had been introduced inearly 1940s and the first attempt was made to develop filament- winding equipment. The equipment that was designed in 1950s was very basic performing the simplest tasks using only two axes of motion (spindle rotation and horizontal carriage). By mid-1970s, machine design once again made a dramatic shift. This time the advancement of servo technology entered the realm of the machine design. High-speed computers allowed for rapid data processing, resulting in smoother motion and greater fibre placement accuracy. The1980s and 1990s sawthe increased use of computer technology. Computers and motion control cards became the essential pieces of hardware that were included in almost every machine. Machine speed control was greatly improved; computer control systemscould trackposition and velocity with increased accuracy. Additional axes of motions were also incorporated into machine design; allowing for four, five and even six axes of controlled motion.

MANUFACTURING TECHNIQUES.

The properties of a composite product are not only dependent on the properties offiber and resin matrix, but are also dependent on the way by which they are processed. There are a variety of processing techniques for fabricating composite parts/structure; resin transfer moulding, autoclave moulding, pultrusion and filament winding. Out of these processes, filament winding involves low cost andis the fastest technique for manufacturing of fiber reinforced cylindrical components as high-pressure pipes and tanks.

Winding methods

There are two different winding methods: (I) wet winding, in which the fibers arepassed through a resin bath and wound onto a rotating mandrel (II) prepreg winding, in which the preimpregnated fiber tows are placed on the rotating mandrel. Among these winding methods, wet winding is more common and widely used for manufacturing fiber reinforced thermosetting matrix composite cylinders. Compared with prepre winding, wet winding hasseveral advantages: low material cost; short winding time; and the resin formulation which can be easily varied to meet specific requirements.

Winding patterns

In filament winding process, the winding tension can easily be controlled. Winding tension, winding angle and/or resin content in each layer ofreinforcement can be varied until the desired thickness and strength of the composite are achieved. The properties of the finished composite can be varied bythe type of winding pattern selected. In general, there are three basic filament winding patterns which are as follows.

Method

Research focusing on existing filament winding methods and equipment technologies is carried out to gather the state of scientific and technical knowledge.For reasons of limitation and simplicity, only a small number of representative filament winding approaches and equipment technologies are presented. The gathered winding techniques are successively subdivided into process clusters with regard to feasible component topologies and the number of necessary winding axes. This classification allows for the allocation of equipment technology to feasible process clusters and possible component geometries at thesame time. In order to make reliable statements concerning process parameters and properties, each equipment technology is established in an experimental environment. Successively, the machineries are investigated with regard to their suitability for the different process clustersby considering economical,operational and qualitative aspects. The results should facilitate the determinationof the most effective equipment choice with a certain part design in mind.

Feasibility

Regarding the premise of a one-sided tool fixation, all different filament windingmethods are achievable with the three combinations of robotic equipment technologies. This can be traced back to the multitude of axes offered by an industrial robot. Thereby even one robot, disregarding whether it handles the toolor fiber guide, is able to cover the entire area aroundthe tooling in all directions. Only the fiber feed and the tool fixation are limiting the windingarea. These circumstances are depicted in Figure 4. The fiber feed is critical if the fiber guide is manipulated. This restriction can be avoided by including the entire fiber preparation intothe fiber guide. The limitation of the tool fixation can only be bypassed by manipulating the tool. This enables a change of grip by releasing andre-grasping the tool at a storage possibility (quick-coupling, storage rack, tool characteristics).

1.2.4 Programming effort

The programming effort of teaching robots winding is currently high due to missing commercial path generation software. The effort for teaching two cooperative robots is significantly higher than for one single robot. The single robot solutions do not distinguish fundamentally in this respect.

OBJECTIVE.

1 To develop a filament winding machine for various fibre composite applications.
2 To analyse the critical components and critical speed during the process
3 Optimize the critical speed for reducing the centrifuge during winding.
4 Optimize the mechanism for filament winding process for effective digital 3Ddesign.

IMPORTANCE

Filament winding machines are essential tools in the manufacturing industry, particularly inthe production of composite materials. These machines automate the process of winding continuous fibres, typically made of materials like carbon fibre or fiberglass, around a rotating mandrel or form to create composite structures such as pipes, pressure vessels, tanks,and other cylindrical or conical components. The importance of filament winding machinescan be summarized as follows:

Efficiency and Automation: Filament winding machines significantly improve production efficiency by automating the filament winding process. They can wind fibers with high precision, consistency, and speed, reducing manual labor and increasing productivity. This automation also minimizes the chances of human error, resulting in more reliable and consistent products.
Cost-effective Manufacturing: Filament winding machines allow for the efficient use of materials, as they precisely control the fiber placement, resin application, and curing process. This reduces material waste and overall production costs. Additionally, the automation of the filament winding process reduces labor costs and increases production capacity, makingit a cost-effective manufacturing method.
Design Flexibility: Filament winding machines offer design flexibility by enabling the production of complex geometries and tailored composite structures. The machines can windfibers in various orientations and patterns, allowing manufacturers to optimize the strength,stiffness, and other mechanical properties of the final product. This versatility is particularlyvaluable in industries where lightweight and high-strength structures are required, such as aerospace, automotive, and sports equipment.

Strength and Durability: Filament winding is known for producing composite structures with excellent strength-to-weight ratios. The continuous fibers wound under tension provide exceptional structural integrity, enhancing the overall strength and durability of the final product. This makes filament winding a preferred method for manufacturing components that require high strength and resistance to external forces.
Application Range: Filament winding machines find applications in diverse industries, including aerospace, defense, automotive, marine, oil and gas, and sporting goods. The ability to produce lightweight, strong, and corrosion-resistant structures makes filament winding an attractive choice for various applications such as aircraft and spacecraft components, pressure vessels, pipes, drive shafts, and sporting equipment.
Material Compatibility: Filament winding machines can work with different types of fibers, including carbon fiber, fiberglass, aramid, and hybrid combinations. This allows manufacturers to select the most suitable material for specific applications, considering factors such as strength, stiffness, temperature resistance, and chemical compatibility.

In summary, filament winding machines play a crucial role in the efficient and cost-effective production of composite structures. They offer design flexibility, enhance strength and durability, and find applications in various industries. Their importance lies in their ability to automate the filament winding process, resulting in improved productivity, high-quality products, and expanded manufacturing capabilities.

II. LITERATURE REVIEW

[1] SAAD MUTASHER, NAZIM MIR-NASIRI, LEE CHAI LIN presented “small-scale filament winding machine for producing fiber composite products” in filament winding process, the fiber is impregnated with resin and wrapped on a cylindrical shape mandrel. The designed machine integrates mechanical, electrical and electronics components all controlled by a single PIC 18F452 microcontroller. The paper presents series of algorithms that control the entire winding processes. The machine generates helical winding patterns with

various angles. The winding patterns are achieved by controlling separately rotational speed of mandrel and translational speed of carriage block on the lead screw. Testing of the prototype shows that it is capable of producing winding angles in the range from 40 to 80 degrees. This machine can use for training the new students as a part from their study of fabrication of long fiber composite materials.

[2] Ma Quanjin, M R M Rejab, Jiang Kaige, M S Idris and M N Harith presented “Filament winding technique, experiment and simulation analysis on tubular structure” Filament winding process has emerged as one of the potential composite fabrication processes with lower costs. Filament wound products involve classic axisymmetric parts, on-axisymmetricparts, based on the 3-axis filament winding machine has been designed with the inexpensivecontrol system, it is completely necessary to make a relative comparison between experimentand simulation on tubular structure. This developed 3-axis winding machine still has weakness compared to CAWIND software simulation results with high axes winding machine about winding pattern, turnaround impact, process error, thickness, friction impact etc. In conclusion, the 3-axis filament winding machine improvements and recommendations come up with its comparison results, which can intuitively understand its limitations and characteristics.

[3] N. Minscha, F.H. Herrmanna, T. Gerekeb, A. Nockeb, C. Cherif presented “Analysis of filament winding processes and potential equipment technologies” The filament winding technique has evolved in recent decades moving from classical lathe-type towards winding with an increased number of degrees of freedom using more complex equipment. These advancements complicate the selection of an optimum winding machine set-up for the realization of particular winding methods and correlating part designs. This is further complicated by the variety of approaches. In order to investigate existing equipment technologies regarding feasibility, operational and economic aspects, different filament winding equipment is established in an experimental environment. Thereby advantageous solutions can be assigned to particular winding methods and the selection of appropriate filament winding equipment is facilitated.

[4] Ma Quanjin*, M R M Rejab, M S Idris, D Bachtiar, J P Siregar, M N Harith presented “Design and optimize of 3-axis filament winding machine”. Filament winding technique is developed as the primary process for composite cylindrical structures fabrication at low cost.Fibres are wound on a rotating mandrel by a filament winding machine where resin impregnated fibres pass through a pay-out eye. This paper aims to develop and optimize a 3-axis, lightweight, practical, efficient, portable filament winding machine to satisfy the customer demand, which can fabricate pipes and round shape cylinders with resins. There are 3 main units on the 3-axis filament winding machine, which are the rotary unit, the delivery unit and control system unit. Comparison with previous existing filament winding machines in the factory, it has 3 degrees of freedom and can fabricate more complex shape specimens based on the mandrel shape and particular control system. The machine has been designed and fabricated on 3 axes movements with control system. Cylindrical specimens with different dimensions and winding angles were produced. 3-axis automated filament winding machine has been successfully designed with simple control system.

[5] F.H. Abdalla, S.A. Mutasher, Y.A. Khalid, S.M. Sapuan *, A.M.S. Hamouda, B.B. Sahari, M.M. Hamdan presented In general, the composite pipes are fabricated using glass fiber and polyester resin matrix by hand lay-up and also by 2-axis filament winding machine.In this work, a filament winding machine was designed and developed for the fabrication ofpipes and round shape specimens. It provides a capability for producing pipe specimens withan internal diameter up to 100 mm and lengths up to 1000 mm. The range of the winding angle, or the fiber orientation angle, starts from 20to 90depending on the mandrel diameter used. Mandrel speed is kept constant as 13.6 revolutions per minute (rpm) while the speed of screw of delivery unit varies from 0 rpm to a maximum of 250 rpm. Tube samples and other circular specimens of different dimensions were produced using this machine for the different mechanical tests and applications.

III. METHODOLOGY

Filament winding is a technique primarily used to manufacture hollow, circular, or prismaticparts such as pipes and tanks. It is performed by winding continuous fiber tows onto a rotating mandrel using a specialized winding machine. Filament wound parts are commonlyused in the aerospace, energy, and consumer product industries.

Filament Winding Process

Continuous fiber tows are fed through a fiber delivery system to the filament winding machine, where they are wound onto a mandrel in a predetermined, repeating geometric pattern. The tow location is guided by a fiber delivery head, which is attached to a movablecarriage on the filament winding machine. The relative angle of the tow to the mandrel axis,called the winding angle, can be tailored to provide strength and stiffness in the desired directions. When sufficient layers of tow have been applied, the resulting laminate is cured on the mandrel. The overall size and shape of the finished part are determined by the mandrelshape and thickness of the laminate.

The winding angles will determine the mechanical properties of the composite part, such asstrength, stiffness, and weight. The density of the laminate is the result of the tension of the tows during winding. The composite parts made through these methods generally have goodstrength-to-weight properties. implementation of the new painting process. By following these steps, businesses can improve the efficiency and quality of their painting process, leading to increased productivity and customer. satisfaction.

Figure 3.1 METHODOLOGY

IV. PROBLEM STATEMENT:

Design and Development and Analysis of Filament Winding machine for Compositematerials

- To design and develop a critical filament winding machine based on the inputsprovided to process variable parameters.
- To compare the effect of various angles on strength and properties of filamentwinding process and control the entire device remotely.

V. SIMULATION

Table 5.1 Initial Temperature Condition

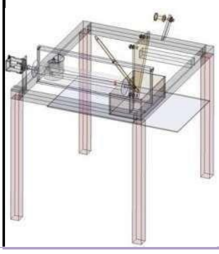
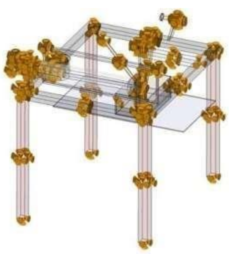
Initial ConditionName	Initial Condition Image	Initial Condition Details
Initial Temperature.1		Type: **Initial Temperature** Value: **Temperature = 295 Kdeg**

Table 5.2 Displacement Condition

Restraint Name	Restraint Image	Restraint Details
Fixed Displacement.1		Type: **Fixed Displacement** Fixed: **Translation X, Translation Y, Translation Z**

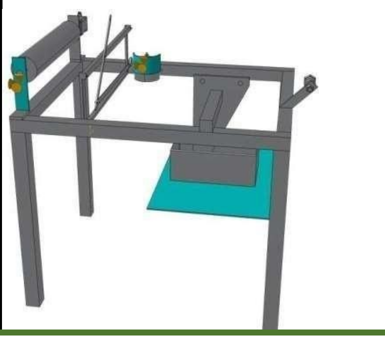
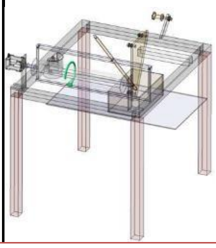
Fixed Displacement.2		Type: **Fixed Displacement** Fixed: **Translation X, Translation Y, Translation Z**

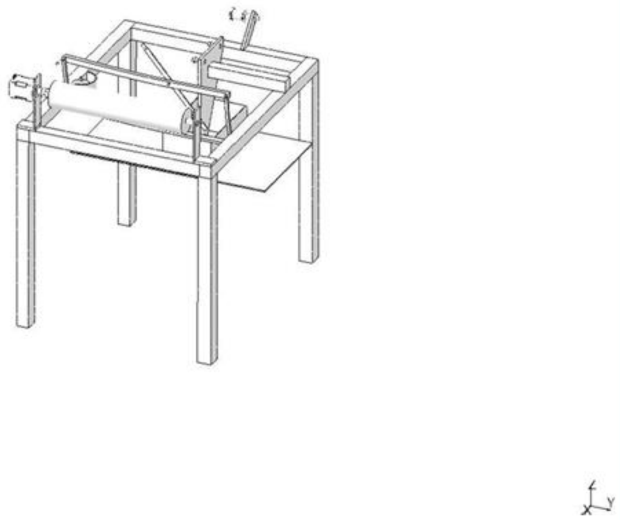
Table 5.3 Load Conditions

Load Name	Load Image	Load Details
Centrifugal Force.1		Value: **10 turn_mn**

SIMULATION RESULTS

Table 5.4 Deformation Result

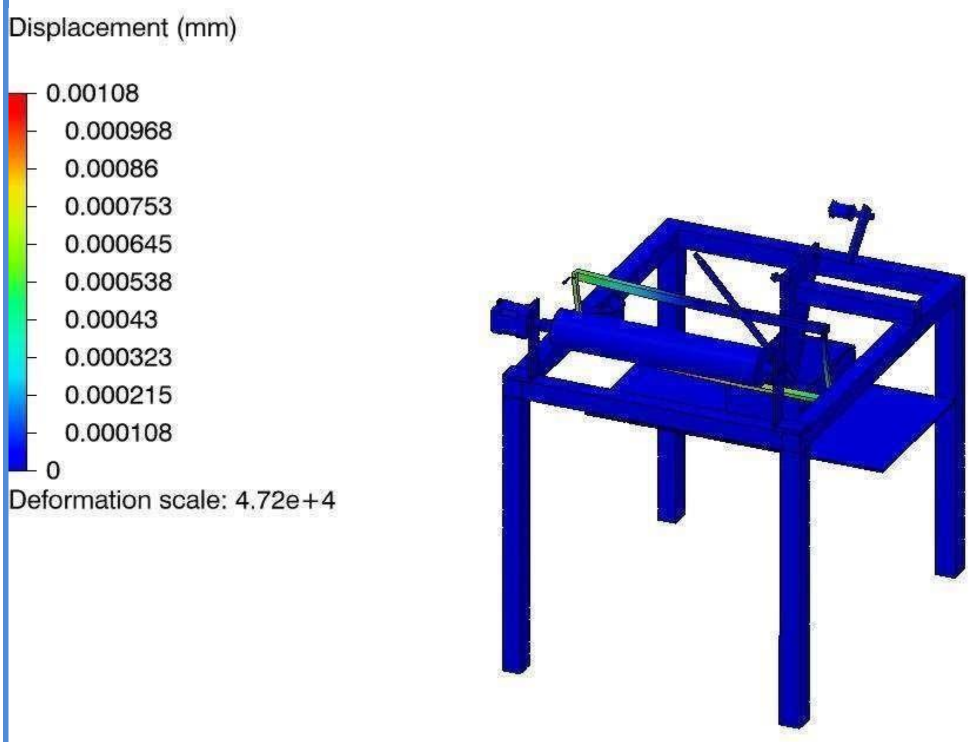
Name	Min	Max	
Deformation	------	------	



Result of Deformation [0]

Table 5.5 Displacement Result

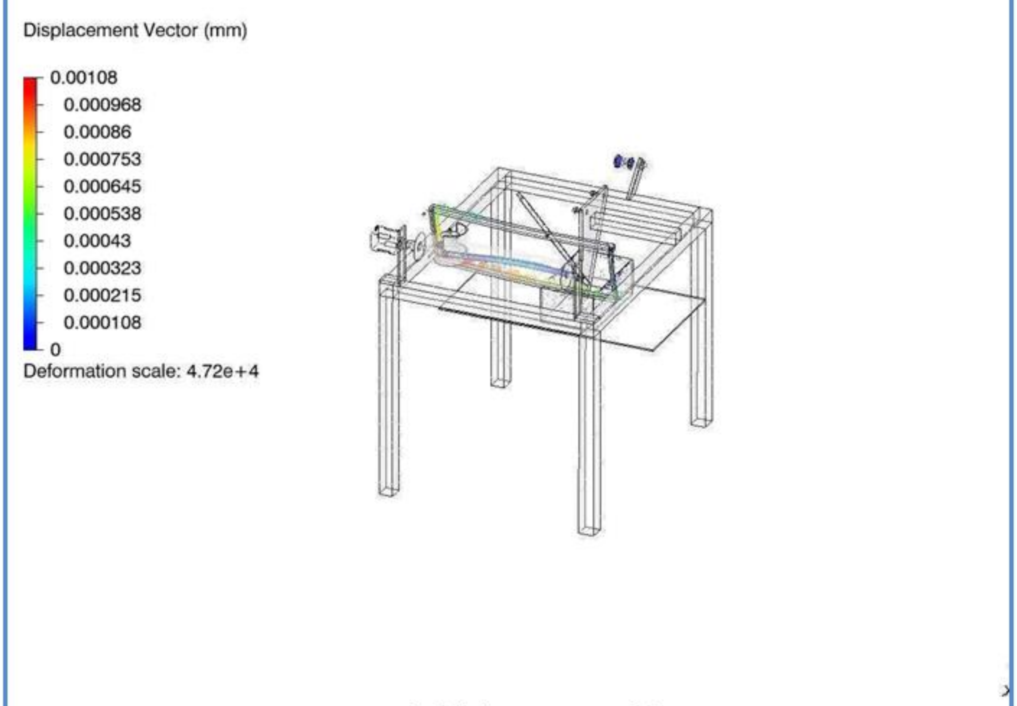
Name	Min	Max	
Displacement	0 mm	0.00107557 mm	



Result of Displacement [0]

Table 5.6 Displacement Vector Result

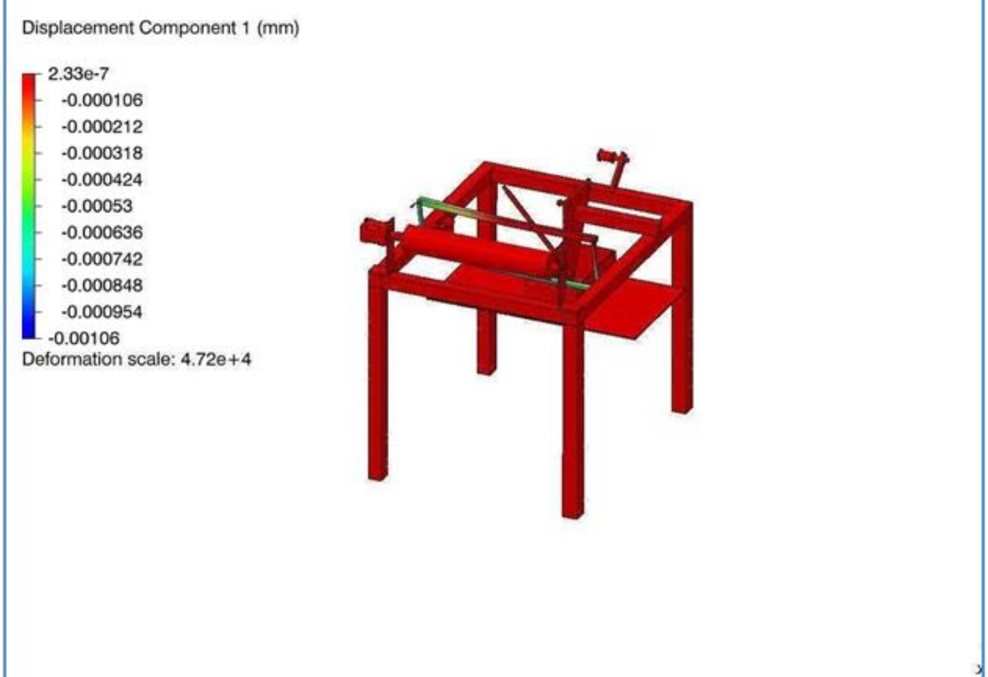
Name	Min	Max	
Displacement Vector	0 mm	0.00107557 mm	



Result of Displacement Vector [0]

Table 5.7 Displacement Component 1 Result

Name	Min	Max	
Displacement Component 1	-0.0010597 mm	2.33344e-7 mm	



Result of Displacement Component 1
[0]

Table 5.8 Displacement Component 2 Result

Name	Min	Max	
Displacement Component 2	-3.35328e-5 mm	3.5014e-5 mm	

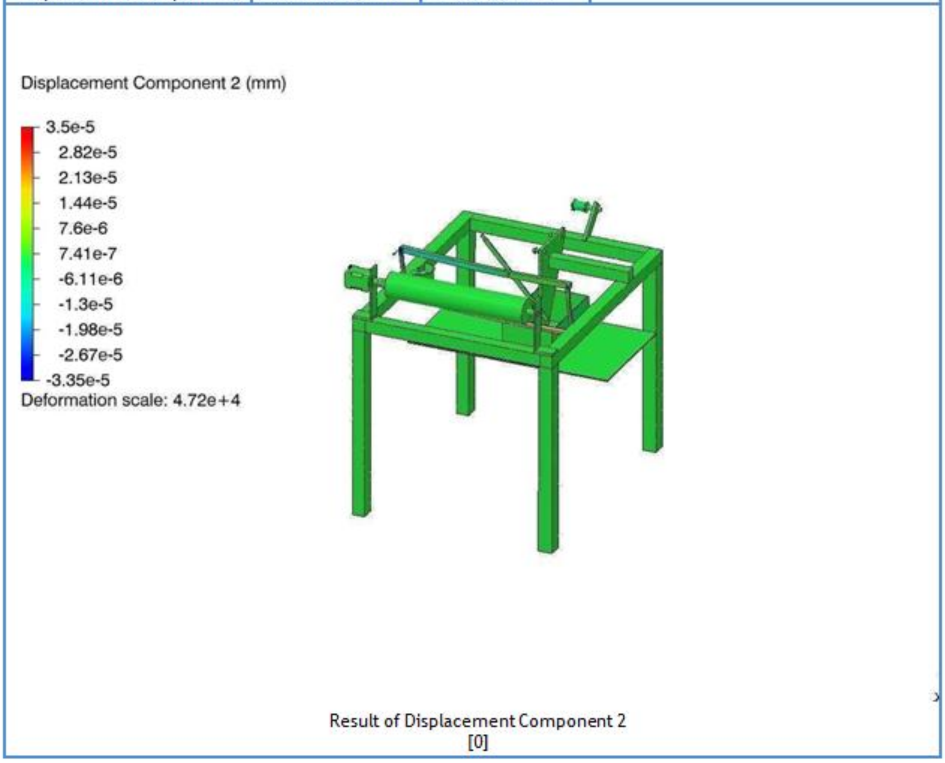


Table 5.9 Displacement Component 3 Result

Name	Min	Max	
Displacement Component 3	-0.000219185 mm	5.39507e-7 mm	

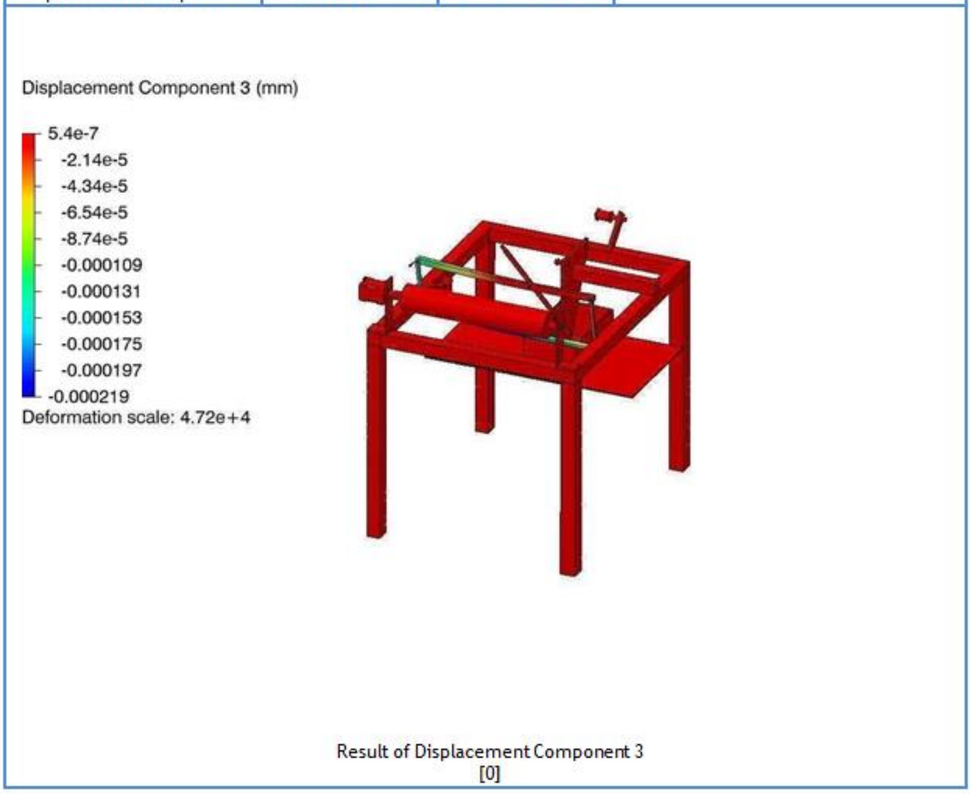


Table 5.10 Von Mises Stress Result

Name	Min	Max	
Von Mises Stress	1.01362e-29 N_m2	69362.1 N_m2	

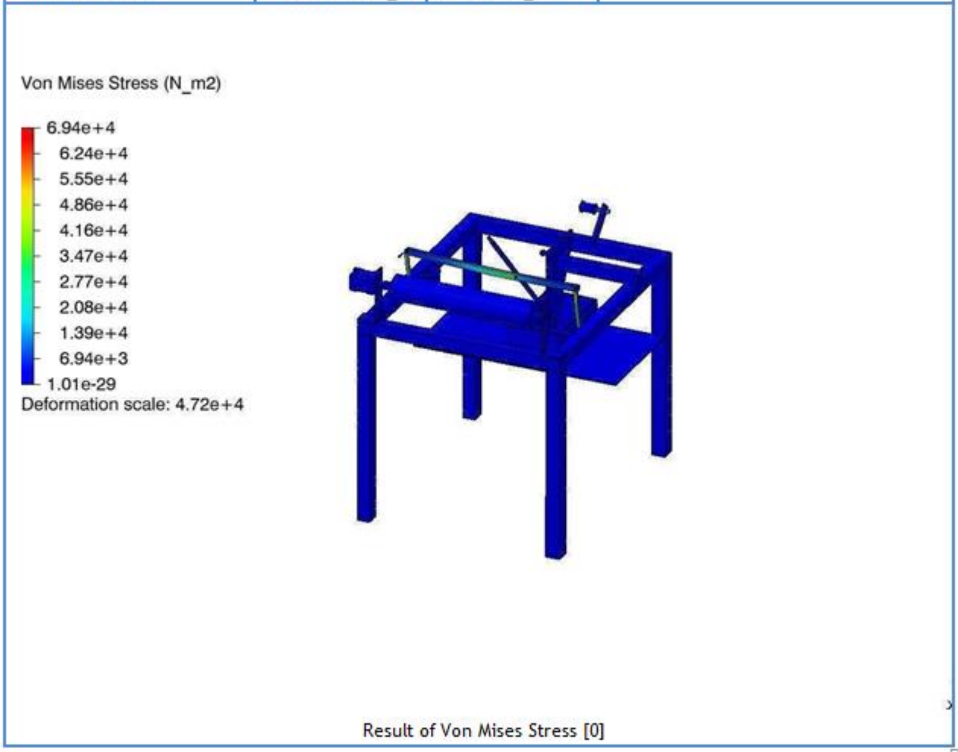


Table 5.11 Principal Stress Direction Result

Name	Min	Max	
Principal Stress Directions	-57736.7 N_m2	65117.9 N_m2	

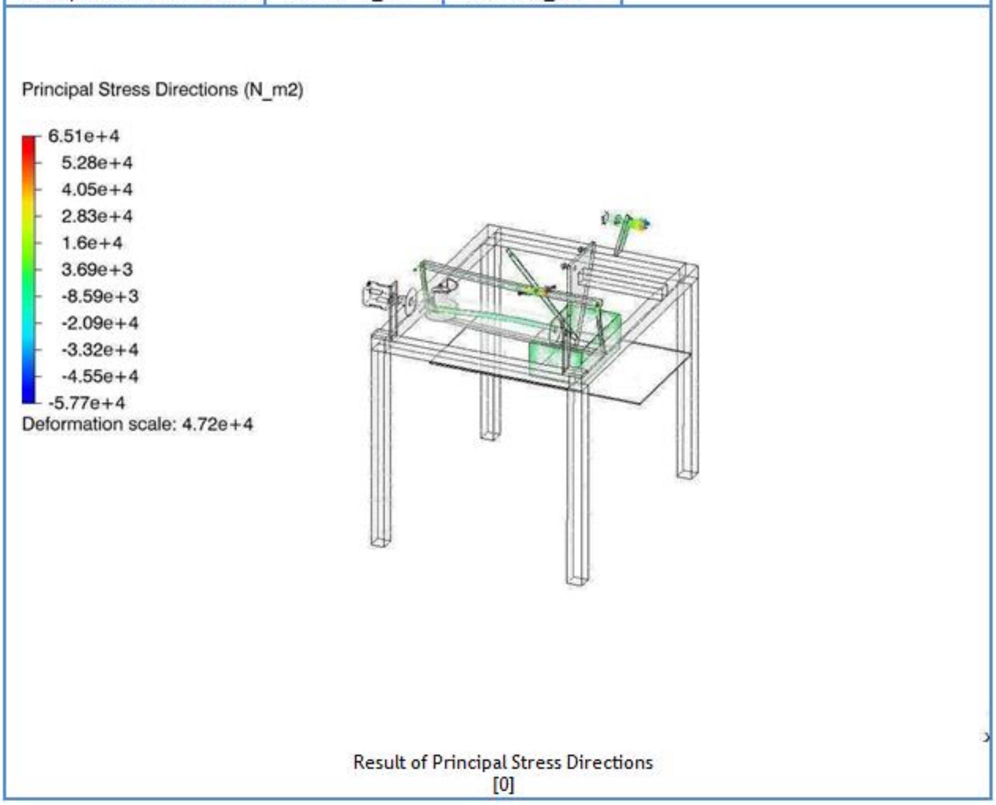


Table 5.12 Stress Component 11 Result

Name	Min	Max	
Stress Component 11	-30378.7 N_m2	33418.4 N_m2	

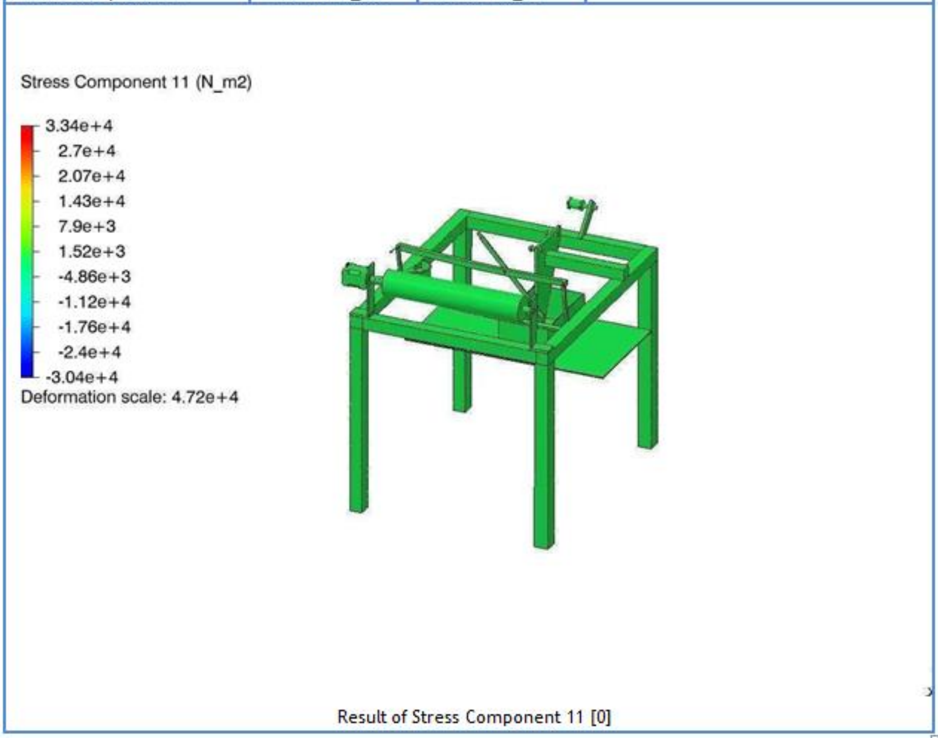


Table 5.13 Stress Component 22 Result

Name	Min	Max	
Stress Component 22	-73617.3 N_m2	79762 N_m2	

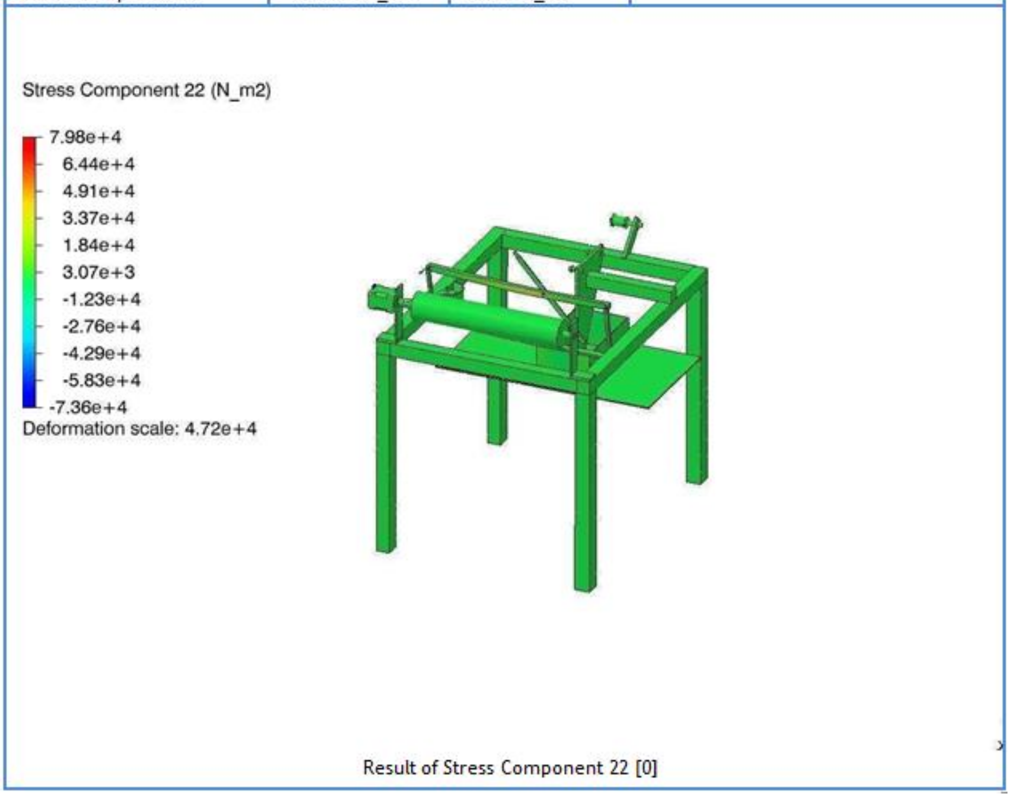
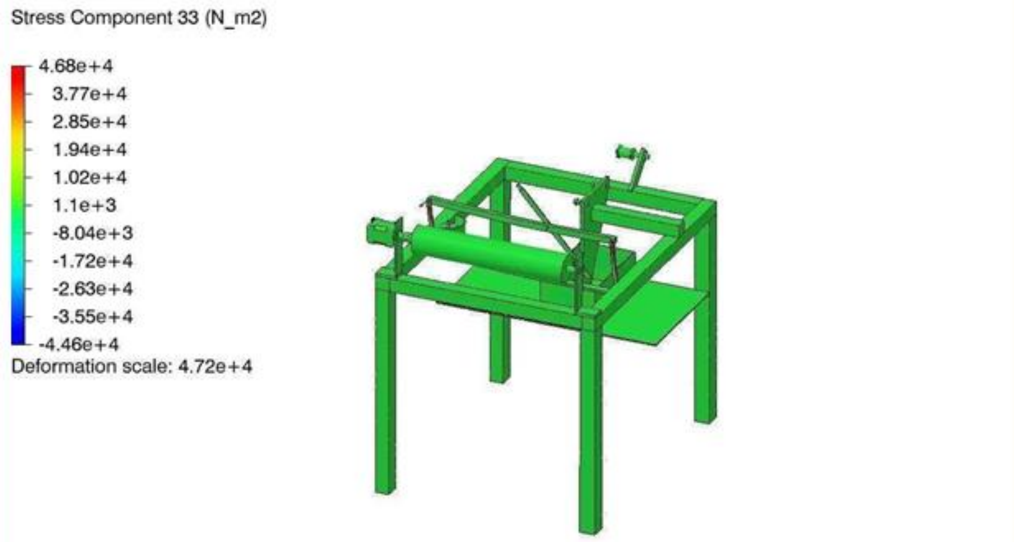


Table 5.14 Stress Component 33 Result

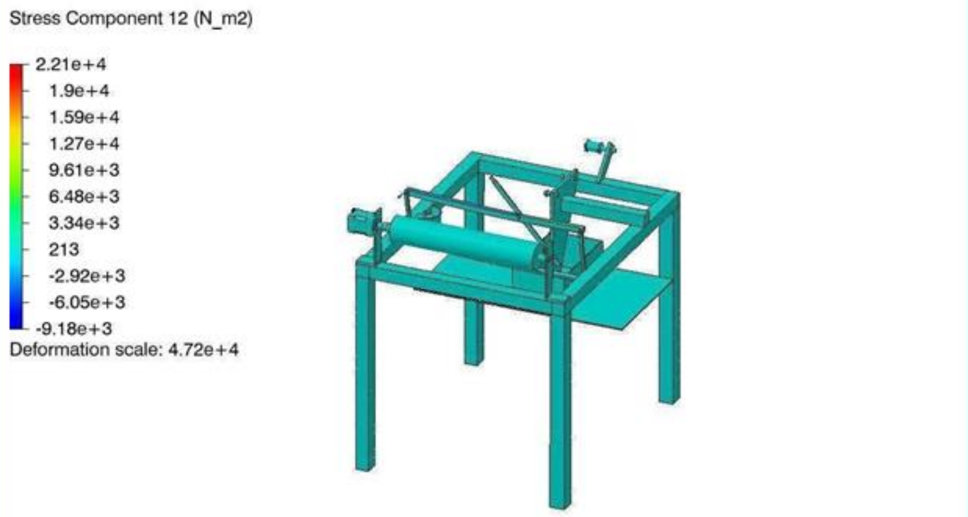
Name	Min	Max	
Stress Component 33	-44596.6 N_m2	46796.1 N_m2	



Result of Stress Component 33 [0]

Table 5.15 Stress Component 12 Result

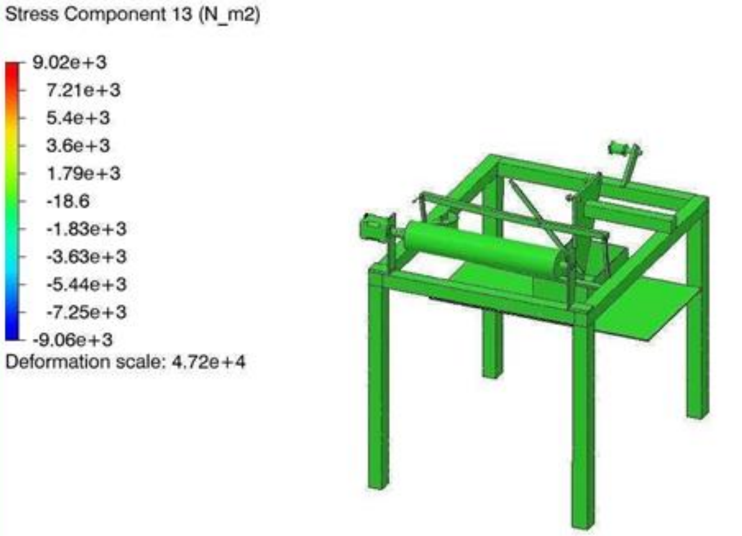
Name	Min	Max	
Stress Component 12	-9180.75 N_m2	22131.7 N_m2	



Result of Stress Component 12 [0]

Table 5.16 Stress Component 13 Result

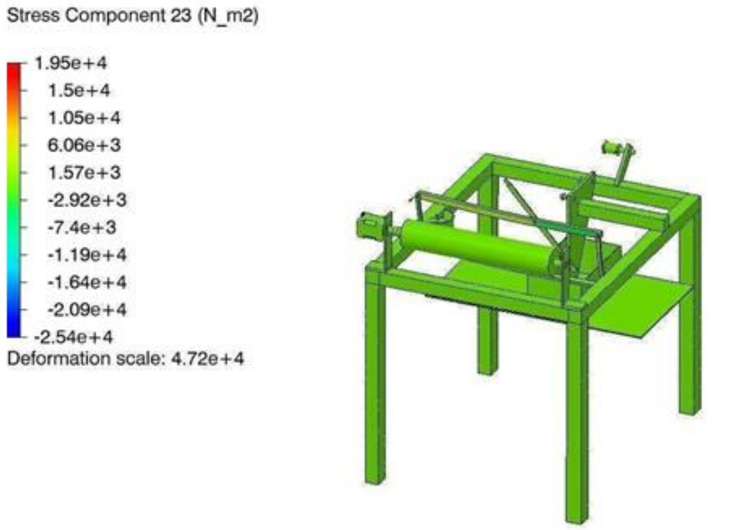
Name	Min	Max	
Stress Component 13	-9057.47 N_m2	9020.26 N_m2	



Result of Stress Component 13 [0]

Table 5.17 Stress Component 23 Result

Name	Min	Max	
Stress Component 23	-25351.4 N_m2	19517.4 N_m2	



Result of Stress Component 23 [0]

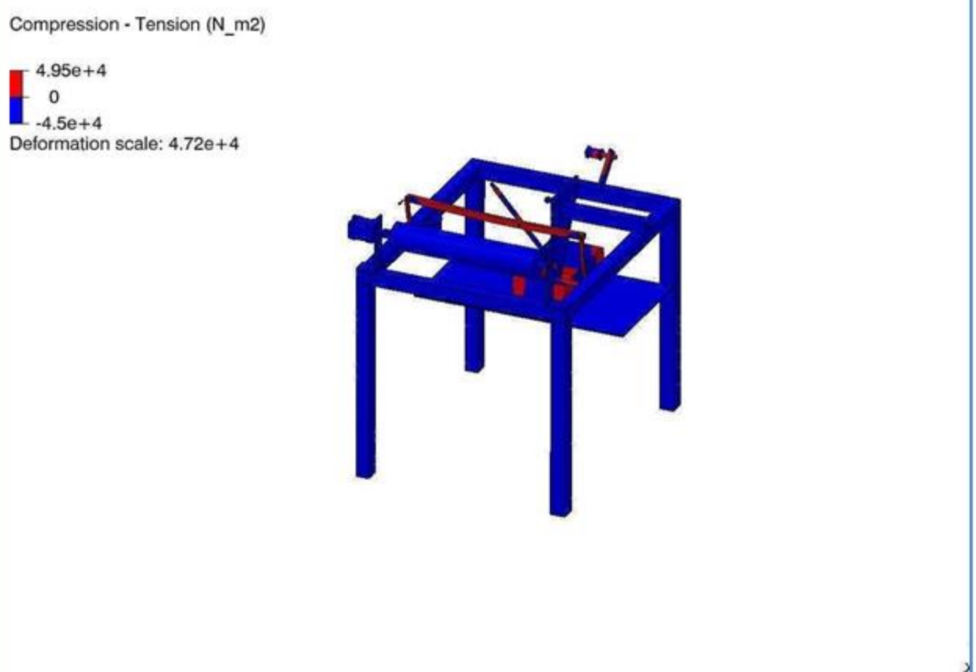
Table 5.18 Factor of Safety

Name	Min	Max	
Factor of Safety	0	2	

Result of Factor of Safety [0]

Table 5.19 Compression-Tension

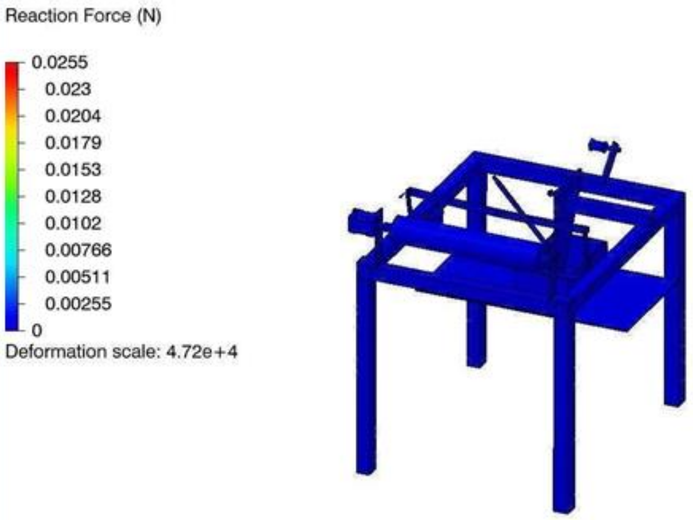
Name	Min	Max	
Compression- Tension	-45027.6 N_m2	49546.9 N_m2	



Result of Compression - Tension [0]

Table 5.20 Reaction Force Result

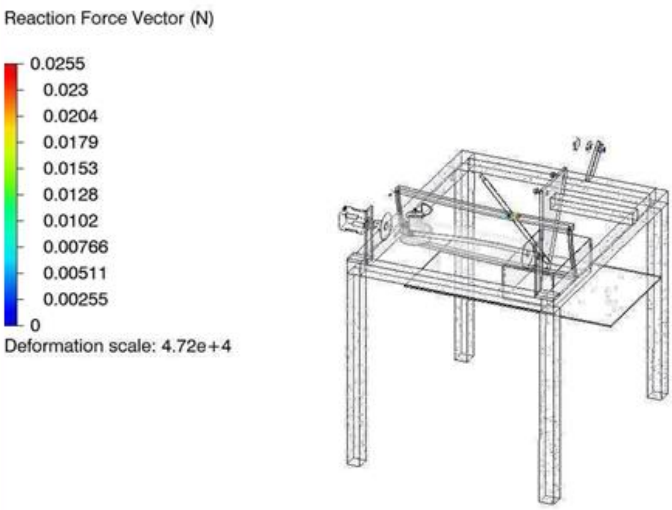
Name	Min	Max	
Reaction Force	0 N	0.0255376 N	



Result of Reaction Force [0]

Table 5.21 Reaction Force Vector Result

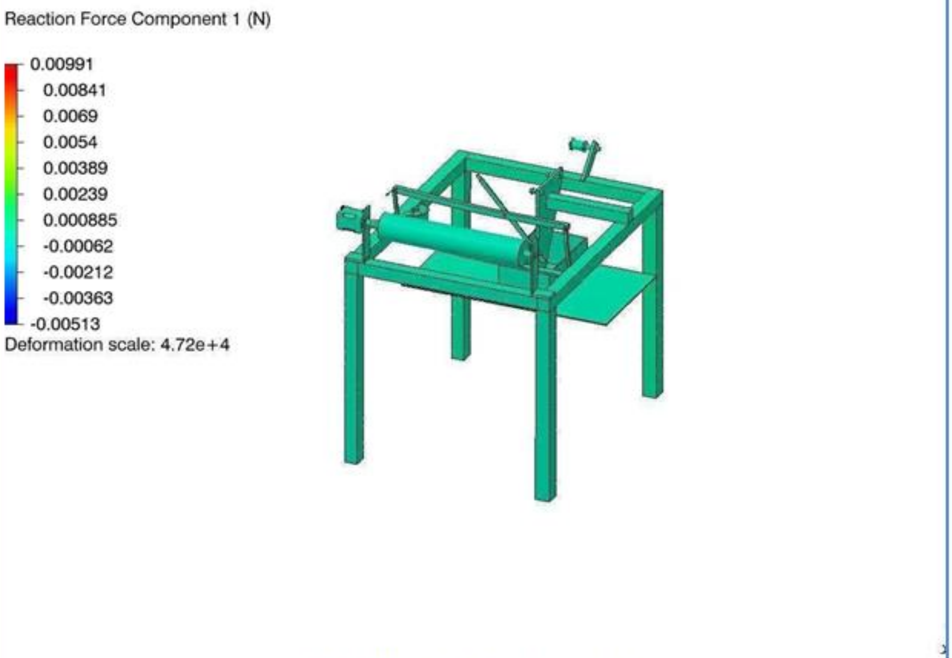
Name	Min	Max	
Reaction Force Vector	0 N	0.0255376 N	



Result of Reaction Force Vector [0]

Table 5.22 Reaction Force Component 1 Result

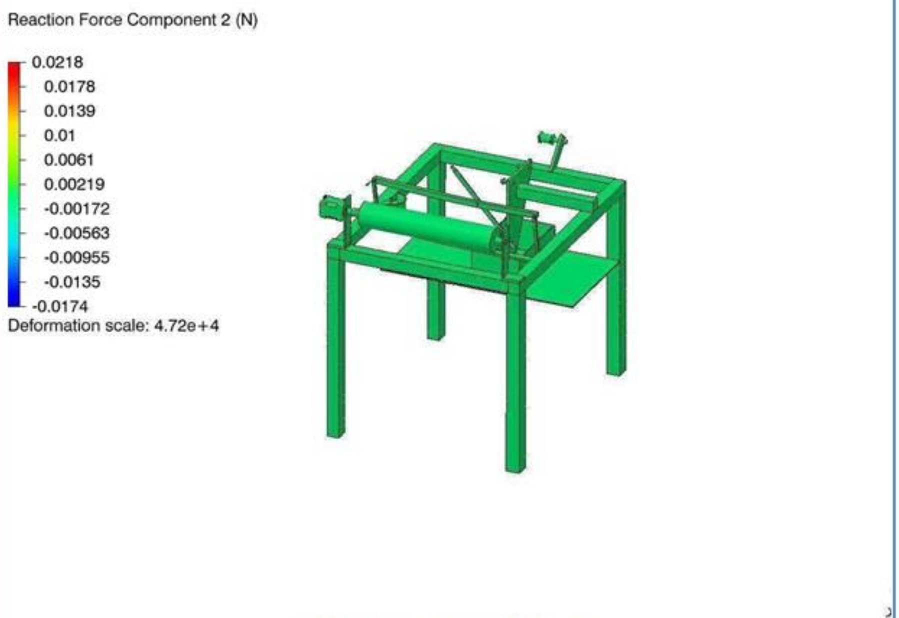
Name	Min	Max	
Reaction Force Component 1	-0.00513234 N	0.00990992 N	



Result of Reaction Force Component 1
[0]

Table 5.23 Reaction Force Component 2 Result

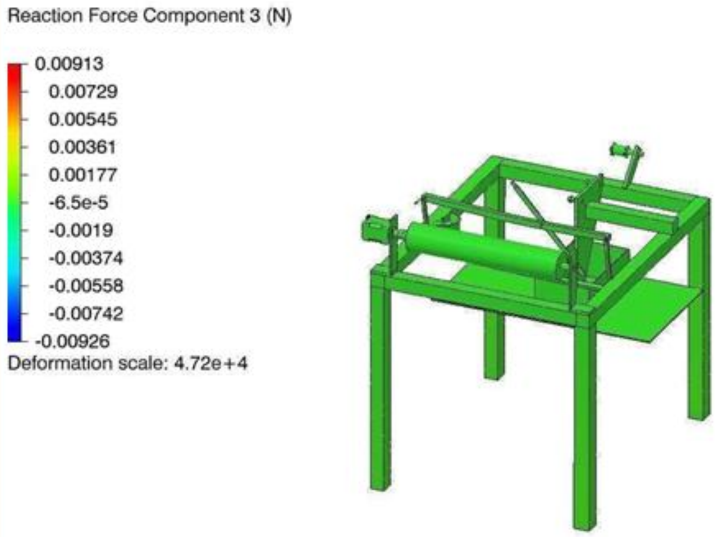
Name	Min	Max	
Reaction Force Component2	-0.017372 N	0.0217529 N	



Result of Reaction Force Component 2
[0]

Table 5.24 Reaction Force Component 3 Result

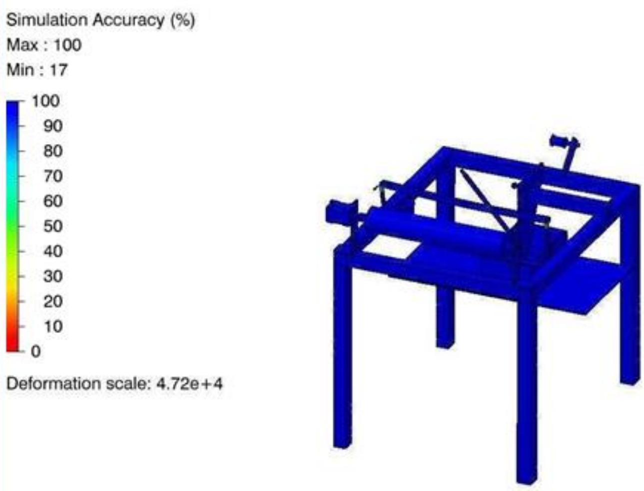
Name	Min	Max	
Reaction Force Component3	-0.00926391 N	0.00913398 N	



Result of Reaction Force Component 3 [0]

Table 5.25 Simulation Accuracy (%) Result

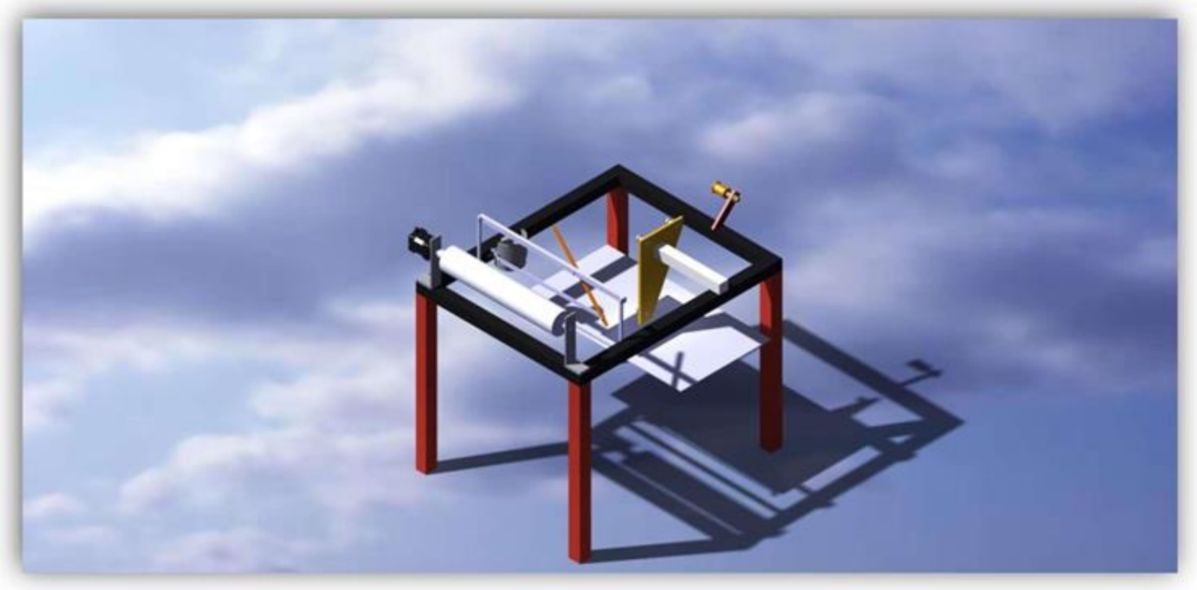
Name	Min	Max	
Simulation Accuracy (%)	0	100	



Result of Simulation Accuracy (%) [0]

VI. DESIGN (3D MODEL)

Figure 6.1 3D MODEL



PROPOSAL MODEL

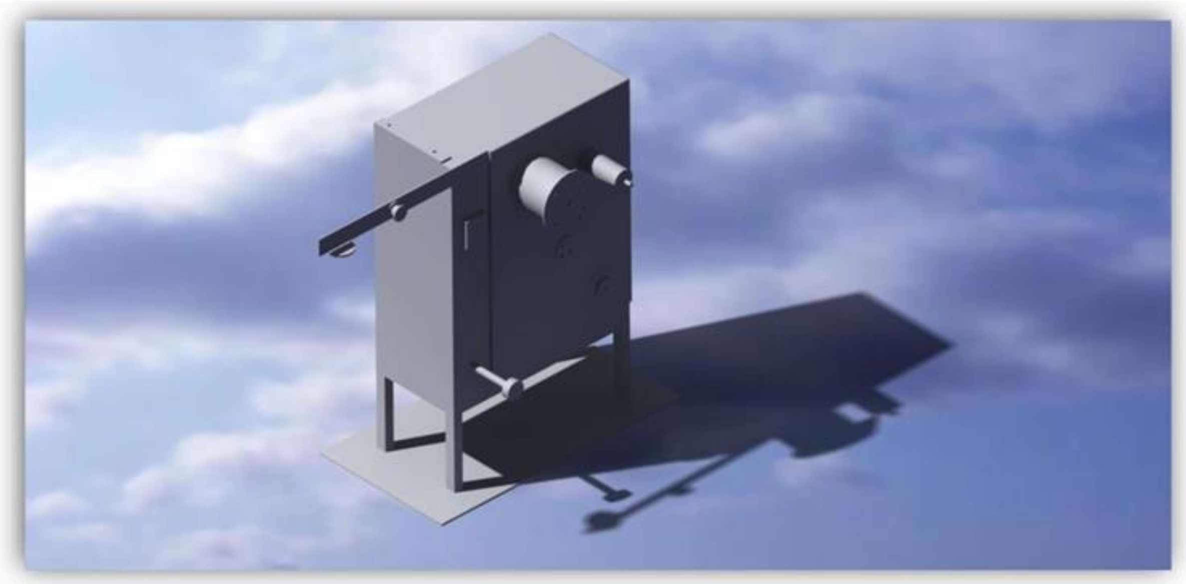


Figure 6.2 PROPOSAL MODEL

MESH PROPERTIES

Figure 6.3 MESHED MODEL

	Finite Element Model00014324 A.1
Number of Nodes	264143
Number of Elements	136396
Element Type	Connectivity: TE10; Statistics: 136396 (100.00%)

Table 6.3 Mesh Properties

VII. DRAFTING

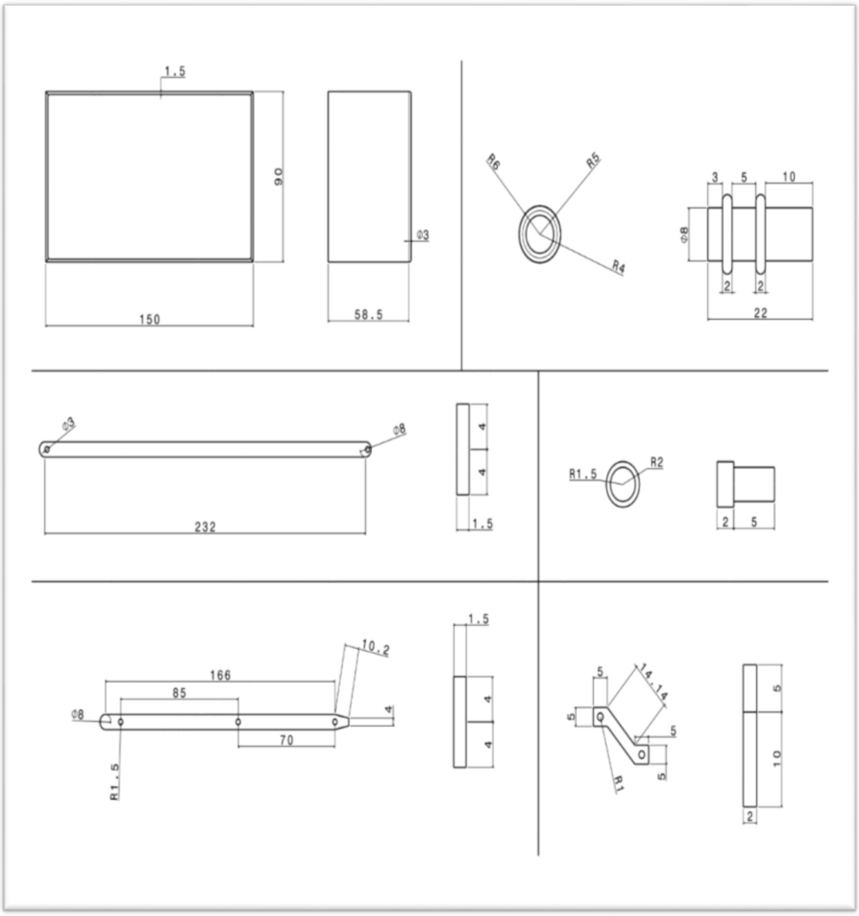


Figure 7.1 Drafting of Components Set 1

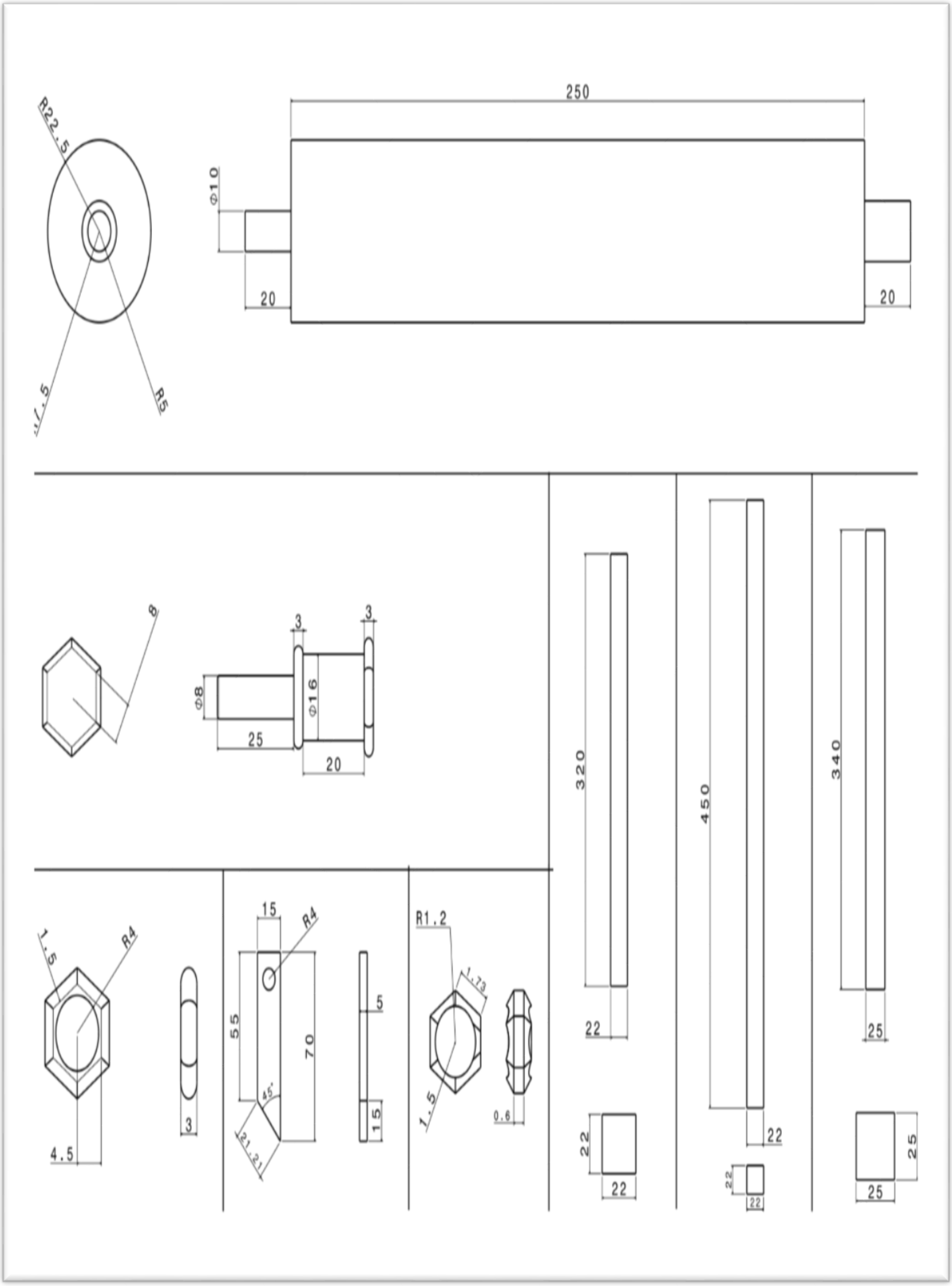
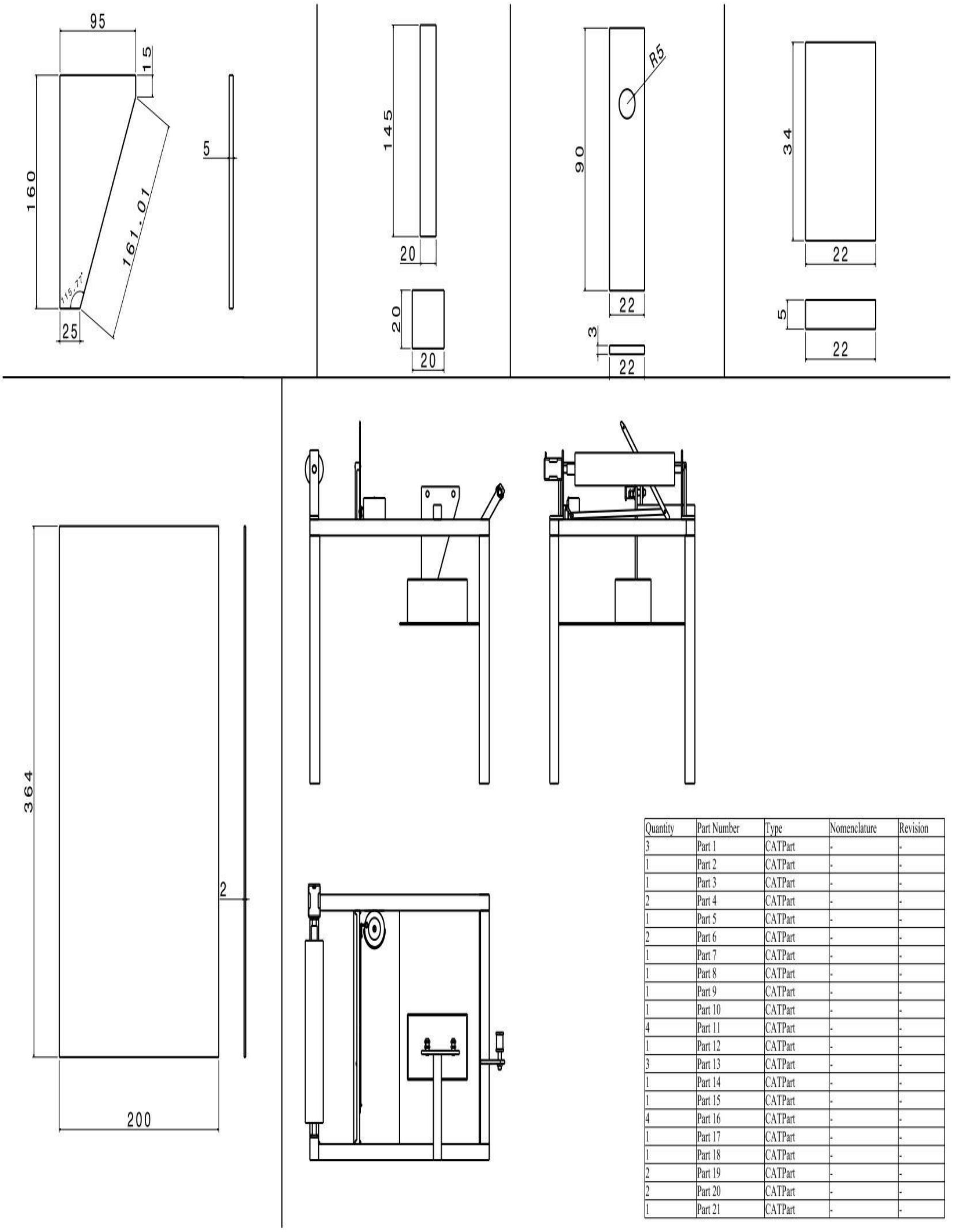


Figure 7.1 Drafting of Components Set 2



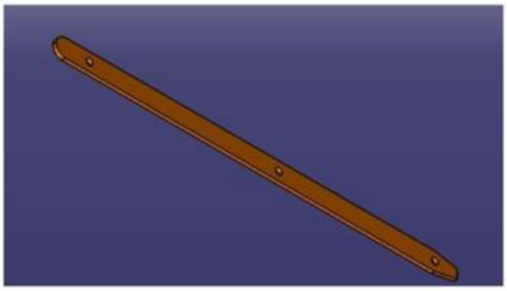
Quantity	Part Number	Type	Nomenclature	Revision
3	Part 1	CATPart	-	-
1	Part 2	CATPart	-	-
1	Part 3	CATPart	-	-
2	Part 4	CATPart	-	-
1	Part 5	CATPart	-	-
2	Part 6	CATPart	-	-
1	Part 7	CATPart	-	-
1	Part 8	CATPart	-	-
1	Part 9	CATPart	-	-
1	Part 10	CATPart	-	-
4	Part 11	CATPart	-	-
1	Part 12	CATPart	-	-
3	Part 13	CATPart	-	-
1	Part 14	CATPart	-	-
1	Part 15	CATPart	-	-
4	Part 16	CATPart	-	-
1	Part 17	CATPart	-	-
1	Part 18	CATPart	-	-
2	Part 19	CATPart	-	-
2	Part 20	CATPart	-	-
1	Part 21	CATPart	-	-

Figure 7.1 Drafting of Components Set 1

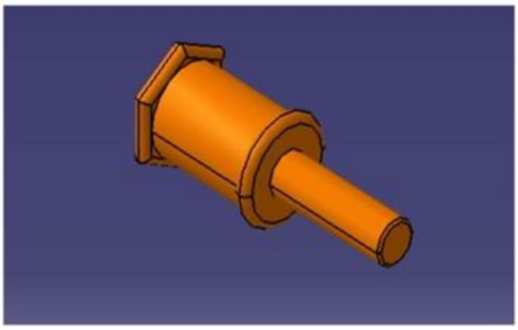
UPDATED DESIGN

Figure 7.4 Isometric View of The Components

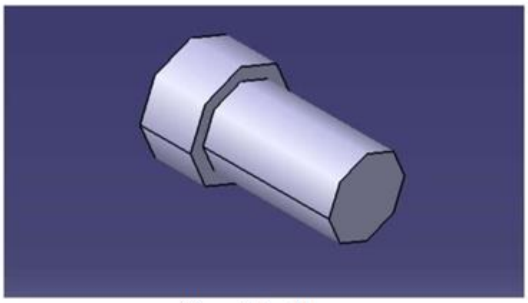
COMPONENTS



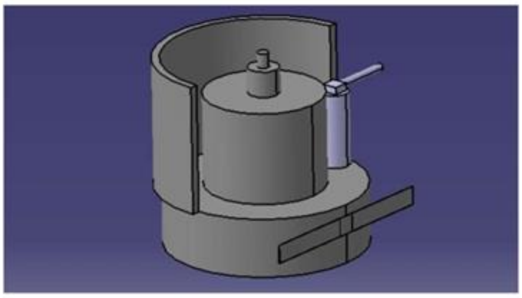
Flat plate with 3 holes



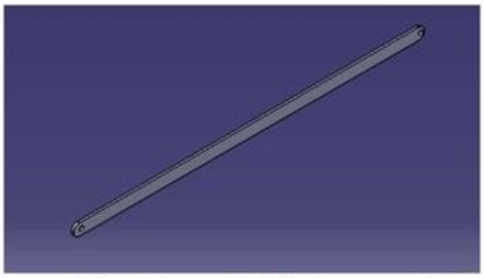
Fiber holder



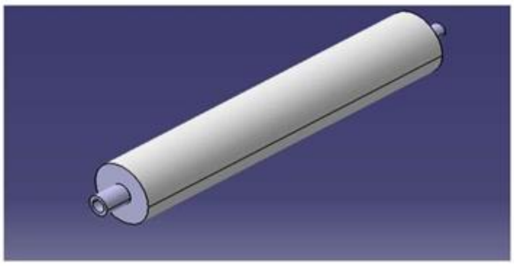
Small bolt



Denso motor (12V)

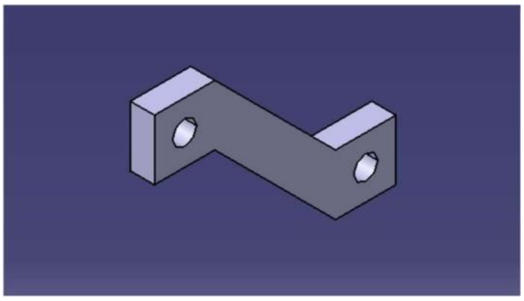


Flat plate with 2 holes at end

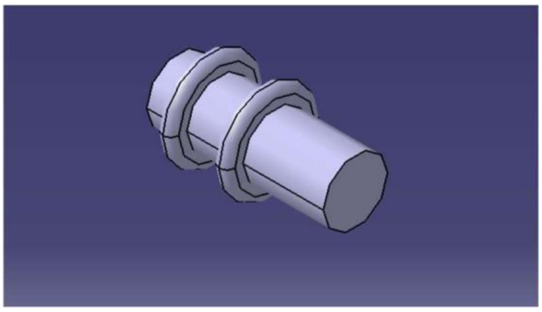


Mandrel

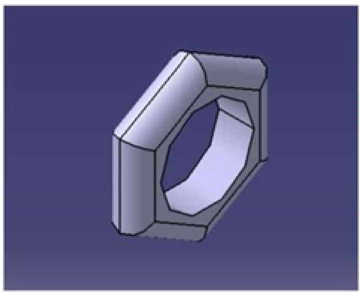
Figure 7.5 Components Set 1



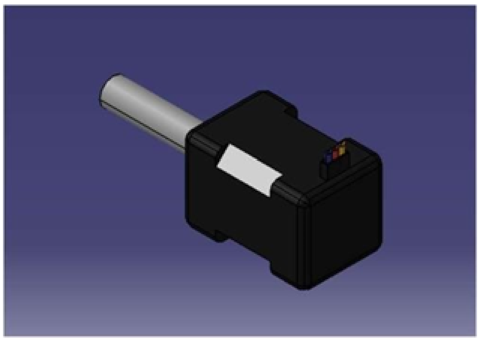
Z-Plate with hole



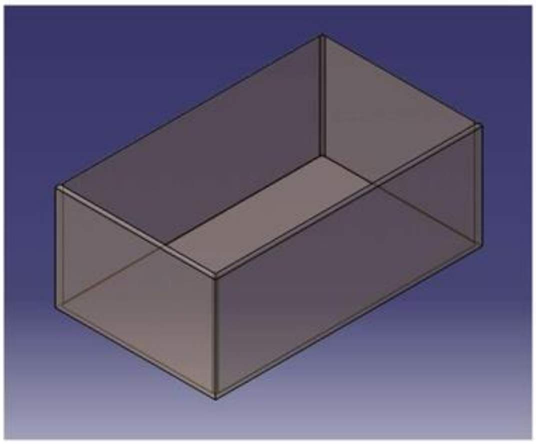
Metal Spool



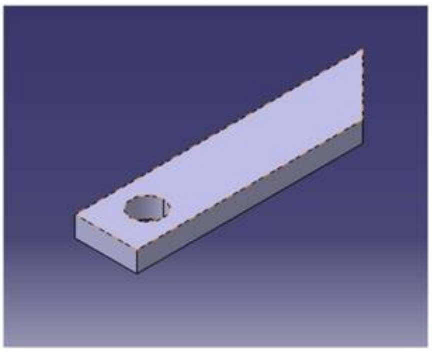
Nut



Motor (12 V , 200r/min)

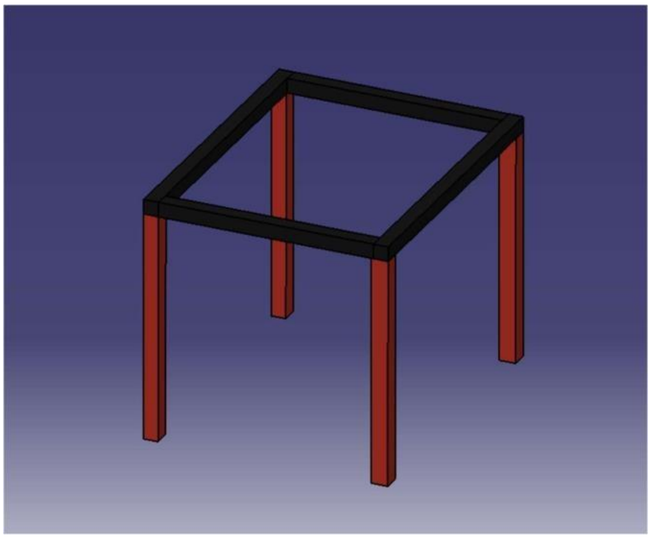


Resin holder

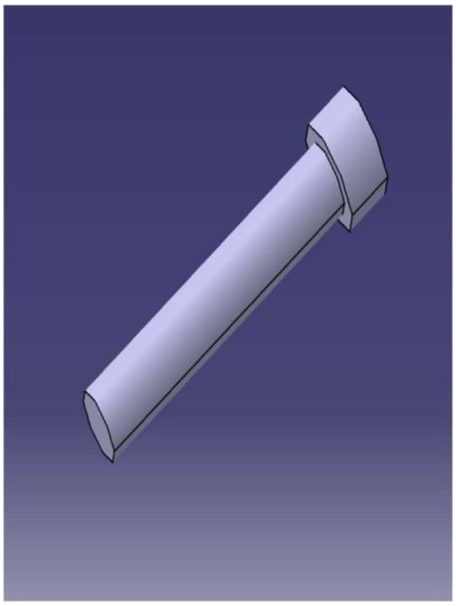


Holder

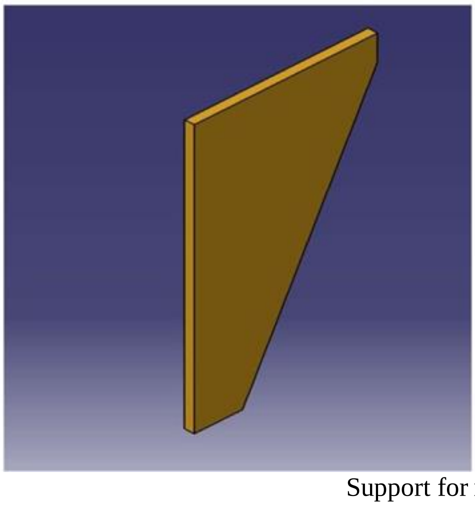
Figure 7.6 Components Set 2

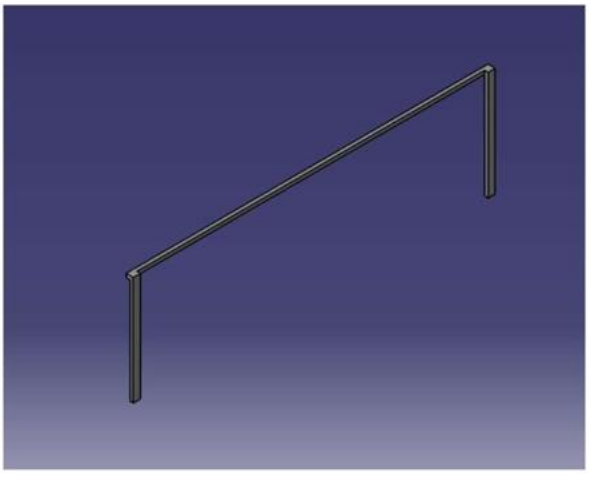


Frame of Winding machine



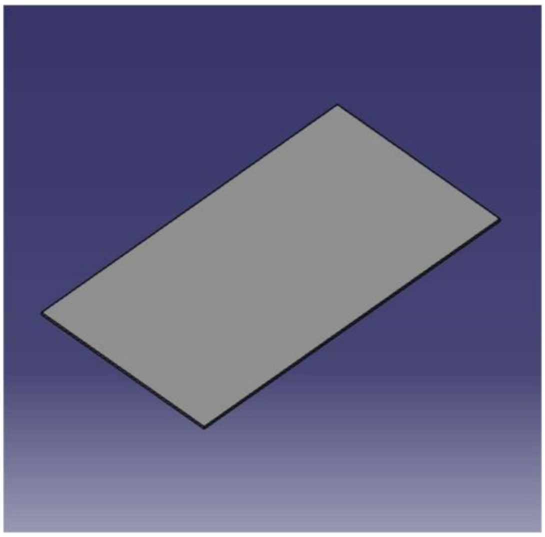
Long Bolt



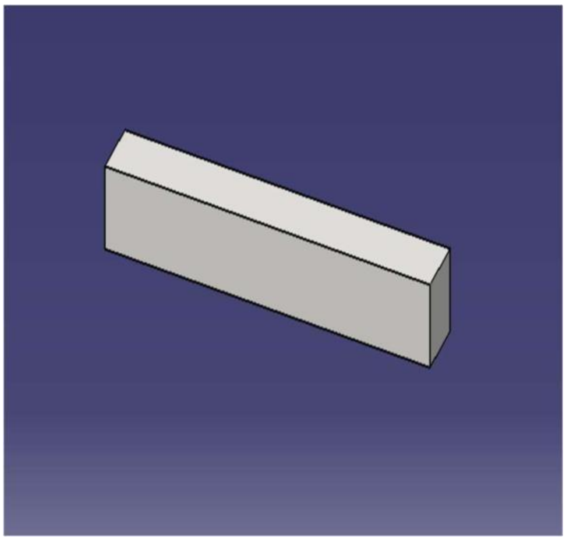


Support for resin Support for Thread

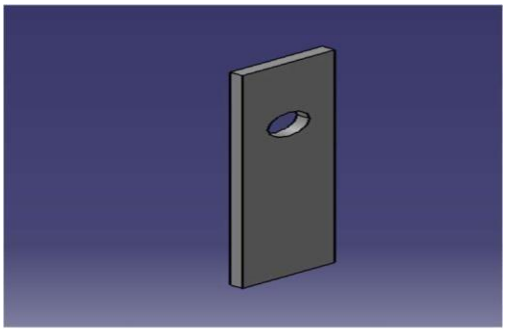
Figure 7.7 Components Set 3



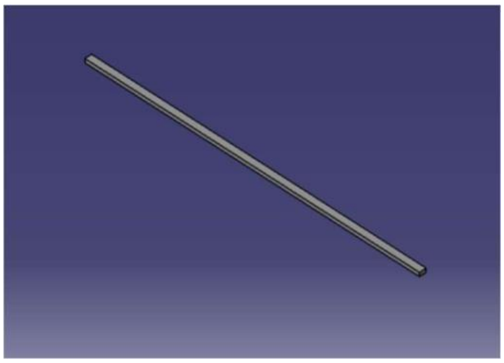
Plate



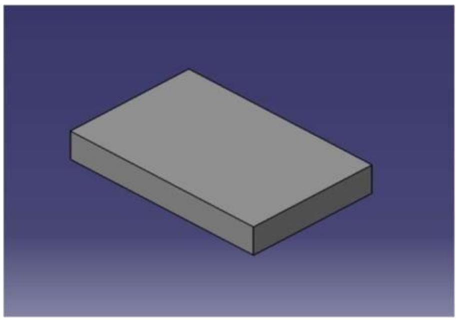
Block



Mandrel holder



Flat plate



Square block

Figure 7.8 Components Set

VIII. MATERIALS USED

Table 8.1 Material Used

Material	Height	Width	Thickness	Area	Quantity
Square Pipe	25mm	25mm	3mm	2518.4 mm^2	8
Iron Plate	100mm	387.8mm	7mm	3878 mm^2	1
Square Rod	10mm	10mm	------	304.8mm^2	1
Iron Plate	110mm	30mm	4mm	330mm^2	2
	40mm	30mm	4mm	120mm^2	1

Plate	70mm	20mm	5mm	140mm^2	1
	78mm	20mm	5mm	156mm^2	2
	81mm	20mm	5mm	162mm^2	1

MACHINES USED

- Welding machine
- Cutter
- **Drilling machine = 10mm drill**

4.5mm drill6.5mm drill

- **Bandsaw cutting machine (Metal cutting / Pipe and rodcutting)**

Figure 8.1 Machine Used for Project

IX. CONCLUSION

In a filament winding process, a band of continuous resin impregnated rovings or monofilaments is wrapped around a rotating mandrel and then cured either at room temperature or in an oven to produce the final product. The technique offers high-speed andprecise method for placing many composite layers. The mandrel can be cylindrical, round or any shape that does not have re- entrant curvature. Among the applications of filament winding are cylindrical and spherical pressure vessels, pipe lines. Modern winding machines are numerically controlled with higher degrees of freedom for laying the exact number of layers of reinforcement. Mechanical strength of the filament wound parts not only depends on the composition of component material but also on process parameters like winding angle, fiber tension, resin chemistry and curing cycle. Good products of different dimensionswere produced using this machine.

FUTURE SCOPE

The Global Filament Winding Machine market is poised for significant growth between 2022 and 2030, with a positive outlook for 2022 and beyond. As key players in the industryadopt effective strategies, the market is expected to expand further, presenting numerous opportunities for advancement.

The Filament Winding Machine Market is a dynamic and constantly evolving industry, with new products and technologies being introduced at a rapid pace. This presents both opportunities and challenges for businesses operating in the market. This report discusses about top industry segments by type (3-Aixs Machine, Multi-Axis Machine), applications (Cotton Textile Industry , Woolen Textile Industry , Linen Textile Industry , Others

) and regions. To succeed in this competitive landscape, companies must stay ahead of the curve and be able to adapt quickly to changing consumer preferences and market trends. Theglobal Filament Winding Machine market research report provides valuable insights and analysis to help businesses navigate this complex landscape and make informed decisions about product development, marketing, and overall business strategy. With its comprehensive coverage of market size, segmentation, and growth trends, this report is an essential resource for any business looking to succeed in the Filament Winding Machine Market.

REFERENCES

[1]. Gutowski TG. Advanced composites manufacturing. New York: Wiley; 1997.
[2]. Babu MS, Srikanth G, Biswas S. Composite fabrication by filament winding-aninsight, 2000. Available from: http://www.Tifac.org.in/news/acfil.html.
[3]. Hull D, Legg MJ, Spencer B. Failure of glass/polyester filament wound pipe. Composites1978.
[4]. Mallick PM. Fiber reinforced composites, materials, manufacturing and design. 2nd ed.New York: Marcel Dekker, Inc.; 1993

BILL OF MATERIALS

Materials	**Quantity**	**Prize**
6mm nut bolt	6	30 rupees
10mm bearing	1	170 rupees
12mm bearing	1	140 rupees
Motor (12V, 200r/min)	1	150 rupees