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PNUEMATIC COMPRESSION MOLDING MACHINE

A Project Report

Submitted in partial fulfillment of the requirements of the degree of
(Bachelor of Engineering)

By

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2019-2020

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CERTIFICATE

This is to certify that the project report titled, **PNUEMATIC COMPRESSION MOULDING MACHINE** submitted to **Anjuman-I-Islam's Kalsekar Technical Campus, Panvel,** submitted by **Patel Akbar, Shaikh Arbaaz, Master Unez, Karbelkar Husban** in **MECHANICAL ENGINEERING** is the bonafide record of project work done by them under our supervision. The content of this report, in full or in parts, have not been submitted to any other institute or university for the award of any degree or diploma.

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ACKNOWLEDGEMENTS

In the name of Allah, the Most Benevolent, the most Merciful. I wish to record immeasurable gratitude and thankfulness to the One and The Almighty Creator, the Lord and Sustainer of the universe, and mankind in particular. It is only through His mercy and help that this work could be completed and it is ardently desired that this little effort be accepted by Him to be of some service to the cause of humanity.

We wish to thank ***University of Mumbai*** and **Anjuman-I-Islam's Kalsekar Technical Campus** for giving us the opportunity to pursue our BE project.

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ABSTRACT

The development of pneumatically operated compression molding machine for polymer composites. The main aim of fabricating this machine is to prepare the fiber reinforced polymer composite samples for testing purpose. Researchers working on composites for research work they require the samples of composites with different composition for the purpose of testing. For that this machine is useful for the researchers and also for the manufacturer to produce small sized less complicated plastic components. In this machine temperature of specimen dies can be controlled automatically by using sensors and by using FRL (filter, regulator and lubricator) unit, the pressure can be controlled. The low density, high strength and high stiffness to weight ratio, fiber reinforced composite materials are manufactured by this machine are low cost. In this research work, the tensile strength of test specimen of Epoxy without Fiber, Epoxy with carbon fiber, and Epoxy with coconut fiber are tested and compared.

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CHAPTER 1

INTRODUCTION

1.1: Introduction

Compression molding process is done in two steps, preheating and pressurizing. Compression molding is a one of the well-known oldest technique used to develop variety of composite products. Because of its ability to develop variety of composite products, the process is versatile. It is a closed die molding with high pressure application. This process is suitable for small to medium size parts.

In industries, different types of molding machines are used; Semi-automatic and Automatic The hydraulic machine can be used in some applications where there is a requirement of high pressure or high load for manufacturing the components, these high capacity molding machines cannot be installed in small scale industries, because the cost of the high capacity hydraulic molding machine are too expensive for the preparation of small sized composite products and also a skilled operator is required to operate these high capacity hydraulic machine. To overcome these problems, it is a need to develop low cost pneumatically operated molding machine. This machine is useful in small scale industries for the production of FRP composites. The initial cost of machine is low and the maintenance cost is minimal. Compression molding machine is used to prepare the FRP composite samples for testing purpose. In this process, the molding material, generally preheated by using heater after filling in a heated mold cavity. The mold is closed with the help of a top force, by using hydraulic cylinder and pressure is applied to force the material into contact with all mold areas. Heat and pressure is maintained until the molding material has cured. Compression molding is a method suitable for molding complex, high-strength fiber reinforcements. It is one of the lowest cost molding methods compared with transfer molding and injection molding;

1.3: Project Motivation

While for searching for project we had consulted our college professor and gone through previous year projects we notice that every year there is one or more than one project related to material research. for this project student had to go outside workshop for making their research model which are very expensive or they have to make there dies of wood material which is not very reliable then while searching for any solution for this we came across research paper. In that research paper they had made an pneumatic compression machine for testing samples like tensile and impact samples than we come with the idea of making this projects.

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1.4: Problem Definition

While making our projects we faced many difficulties, first we faced difficulty in design the machine. We have to figure what will be the structure where will install pneumatic system and where to install electronic equipment then we face problem in making die for the testing model. we have to work on CNC for making a die of 5 mm deep in an 18 mm thick stainless steel plate .it took as more than a week to make a die on CNC than we faced some difficulty in installing the pneumatic cylinder. We have to install in the center of the structure. We have to make it perfectly balanced so that while punching it doesn't imbalance. And the last and the most difficult problem we face was in selecting which electric temperature controller we need.

1.5: Objectives

1. The objetive of this device is to produce a sample of composite material which can be used for reasearch purpose.

2. Can produce composite output for use.

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CHAPTER 2

LITERATURE REVIEW

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2.1: Introduction

There is different type of Compressed Molding machines are available in market, but they are mainly used for mass production in large scale industries due to high cost of machine components, high pressure and more space required. According to customer reviews the needs have been identified as mainly cost, easy to operate, better product quality and suitable for used in small scale industries [4]. The pneumatic Molding Machine Consist of various components. There are mainly two cylinder used upper Cylinder & Lower Cylinder, Compressor, pressure regulator, Direction control Valve, clamping holder, nozzle, cylinder guide, coupling, Flow control Valve. The Computational analysis using 3 D Modeling CAD and Pro-E in manufacturing of machine is help to design perfect components and parts with minimum modification and also reduce the time and cost. Analysis provides an insight into the nature of processing and consequently offers valuable input towards the design of mold.

2.2: List of papers

[1] PravinPopatraoShinde, S SPatil, Swapnil S Kulkarni "Design & Development of Plastic Injection mold for auto components" in International Journal of Advanced Engineering Research and Studies, Vol. 4 Issue 1 Oct-Dec. 2014, Pages 27-30.

[2] L.M. Galantucci, R Spina, "Evaluation of filling conditions of injection molding by integrating numerical simulation and experimental tests" in ELSEVIER-Journal of Material processing & Technology, 141(2003) Pages 266-275.

[3] SharifahImihezri Syed Shahruddin, Mohd. SapuanSalit, EdiSyamsZainudin, "A review of the effect of Molding parameters on the Performance of polymeric composite injection Molding" Turkish J Engg. Env. Sci., 30, 2006, Pages 23-34.

[4] Eranna H, "Development of Pneumatically operated compression Molding Machine" in International Journal of Engineering Research, Vol.2 Issue 4 Oct. 2014, Pages 6267.

[5] Poonam G Shukla, Gaurav p Shukla, "Design & Fabrication of Pneumatically operated injection Molding Machine, in International Journal of Engineering & innovative Technology (IJEIT), Vol. 2, Issue 7, January 2013, Pages 98101.

[6] Crawford, R., 1998. Plastic Engineering, 3rd ed. Oxford: Butterworth – Heine-mann.

[7] N Sreenivasulu, D Ravikanth "Injection Molding Tool Design Manufacturing, estimation and comparison of L&T power box side panel using plastic material HDPE, ABS, PP and PC", IOSR

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Journal of Mechanical & civil Engineering (IOSR-JMCE) Vol. 8, Issue 3 (Sep.-Oct2013) Pages-23-32.

[8] TSung -Yen Ling, Ming-ShyanHaung, "Designing robust parameter for Injection Compression Molding light guided Plates based on desirability function & Regression model" in International Journal of Engineering & Technology IJET-IJENS, Vol.14, Issue 01, Feb. 2014, Pages 93-107.

2.3: Conclusion

From the above papers and studies we have decided to select the polymer matrix which is composed of natural fiberize. polypropylene composed with wheat straw fibers in order to make the useful composite. In the above papers, there are various type of composite matrix are made. In spite of doing work on same composite, we decided to compose a different matrix.

Polymer matrix which contains wheat fibers as reinforcing filler in the polymer matrix and are advantageous over the pure polymers in terms of the materials cost and some mechanical properties such as modulus and strength.

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CHAPTER 3

METHODOLOGY

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METHODOLOGY

Compression molding is a technique to develop variety of composite products. In this method, as shown in figure 1, two matched metal dies are used to fabricate composite product by the application of compressive force. In this, lower or bottom plate is stationary while upper plate is movable. Reinforce element (Carbon Fiber) and matrix (Epoxy) are placed in the lower die. Heat and pressure is applied as per the requirement of composite for a definite period of time. Due to application of pressure and heat, the material placed in a dies/molds flows and acquires the shape of the mold cavity. Curing of the composite may carried out either at room temperature or at some elevated temperature. After curing, mold is ejected and composite product is extracted by dismantling split die for further processing.

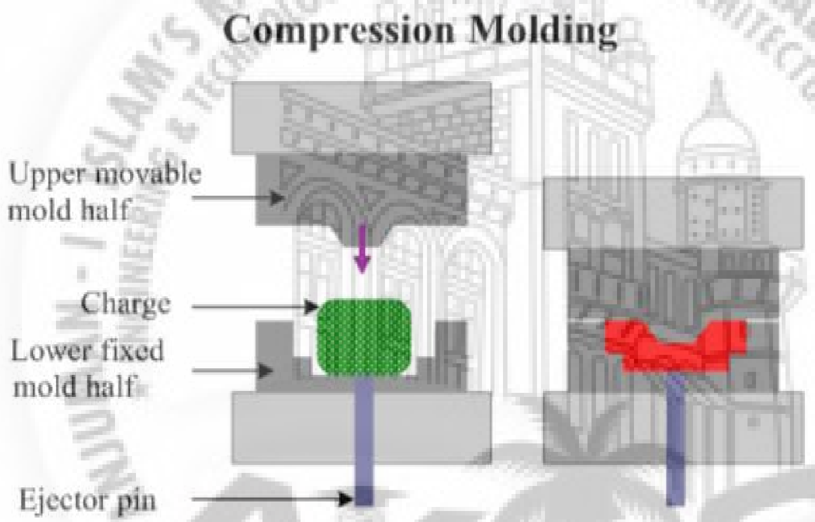

Fig 1 :Compression Molding

In fig 1 the process of compression molding begins with the material is placed into the mould the product is heated until somewhat soft and pliable. A hydraulic tool presses the material against the mould. Once the material is hardened and has taken shape of the mould it is ejected.

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CHAPTER 4

STRUCTURE DESIGN

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4.1: Mold preparation

To produce the samples of composite in order to test the mechanical properties i.e. impact, tensile, flexure and water absorption property, there is a need of mold of a particular dimension as per the ASTM standard. So the mold was made up of steel and to create the molds two machining process had done are as follows: -

Basic process

1. Place a pattern in sand to create a mold.
2. Incorporate the pattern and sand in a gating system.
3. Remove the pattern.
4. Fill the mold cavity with molten metal.
5. Allow the metal to cool.
6. Break away the sand mold and remove the casting.

4.1.1: Milling

In fig 2 the process of machining using rotary cutters to remove material by advancing a cutter into a work piece is called milling. This may be done varying direction on one or several axes, cutter head speed, and pressure. Milling covers a wide variety of different operations and machines, on scales from small individual parts to large, heavy-duty gang milling operations. It is one of the most commonly used processes for machining custom parts to precise tolerances.

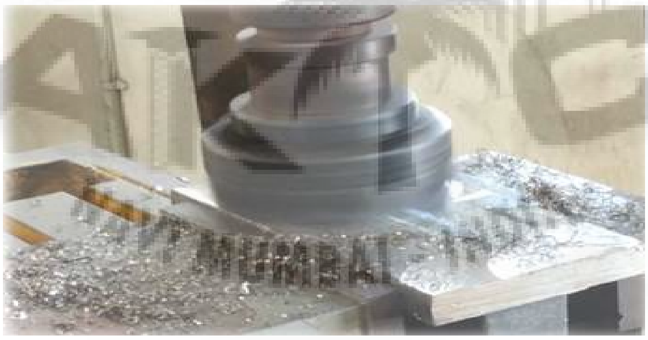

Fig 2 : Milling Process

Milling can be done with a wide range of machine tools. The original class of machine tools for milling was the milling machine (often called a mill). After the advent of computer numerical control (CNC) in the 1960s, milling machines evolved into *machining centers:* milling machines augmented by automatic tool changers, tool magazines or carousels, CNC capability, coolant

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systems, and enclosures. Milling centers are generally classified as vertical machining centers (VMCs) or horizontal machining centers (HMCs).

The integration of milling into turning environments, and vice versa, began with live. Tooling for lathes and the occasional use of mills for turning operations. This led to a new class of machine tools, multitasking machines (MTMs), which are purpose-built to facilitate milling and turning within the same work envelope

Fig 3: Finished Product (Milling)

Fig 3 shows the finished product of milling operation. After milling process grinding operation is carried out to increase the surface finish. The dimension of the die is 185x92x14 mm.

4.1.2: CNC Machining

Most CNC milling machines (also called machining centers) are computer controlled vertical mills with the ability to move the spindle vertically along the Z-axis. This extra degree of freedom permits their use in die sinking, engraving applications, and 2.5D surfaces such as relief sculptures. CNC machines can exist in virtually any of the forms of manual machinery, like horizontal mills. The most advanced CNC milling-machines, the multiaxis machine, add two more axes in addition to the three normal axes (XYZ). Horizontal milling machines also have a C or Q axis, allowing the horizontally mounted work piece to be rotated, essentially allowing asymmetric and eccentric turning. But the skill to program such geometries is beyond that of most operators. Therefore, 5-axis milling machines are practically always programmed with CAM.

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The operating system of such machines is a closed loop system and functions on feedback. These machines have developed from the basic NC (NUMERIC CONTROL) machines. A computerized form of NC machines is known as CNC machines. A set of instructions (called a program) is used to guide the machine for desired operations. Some very commonly used codes, which are used in the program are:

Fig 4: Finished Product(CNC)

Fig 4shows the finished mould. The shape inside the mould is according to ASME standard. The thickness of the mould 5mm.

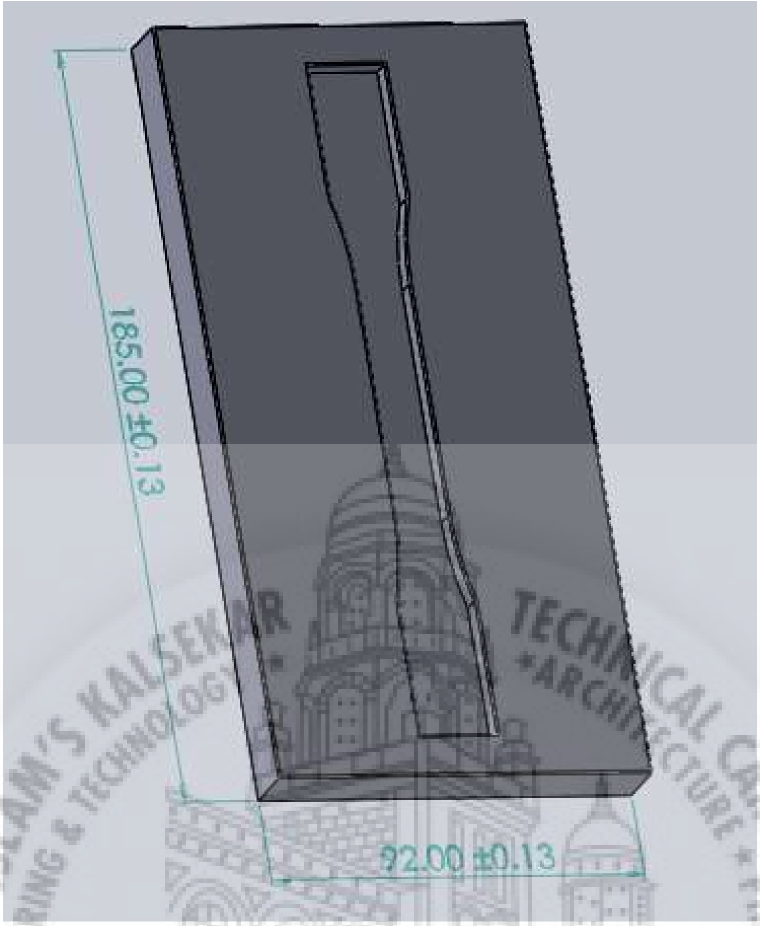

FIG 5: 3D MODEL OF MOULD

Fig 5 shows the 3d model of mould. Mould size is 185x92x14 mm. The material of mould is carbon steel.

4.2: BODY STRUCTURE

4.2.1: MAIN BODY DESIGN

Material used for body is cast iron.

Dimensions. (All dimension are in inch).

4 columns length: 27.

Base support plate (square): 45

Base support: 2

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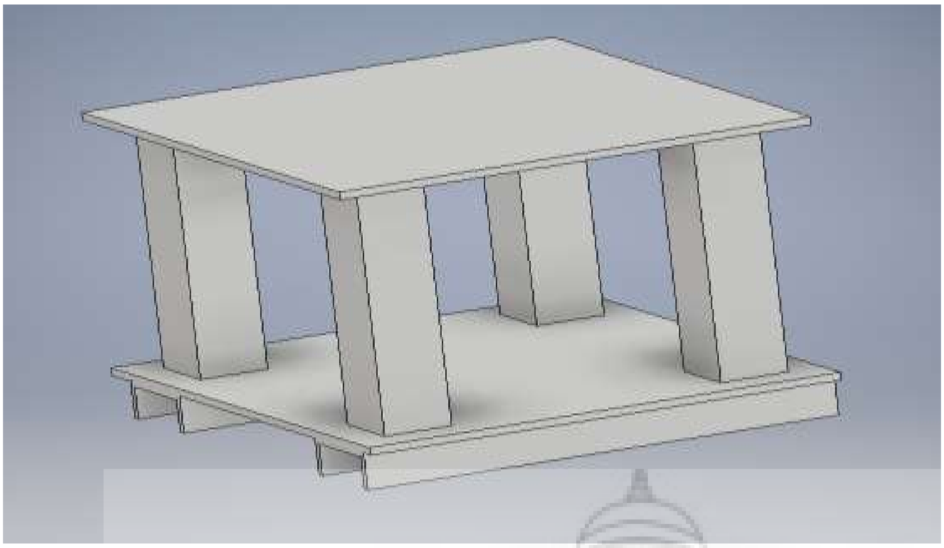

Fig 6: Machine Structure

The fig 6 shows the structure or body of the pneumatic compression machine. The material of the structure is carbon steel.

4.3: ELECTRIC CIRCUIT

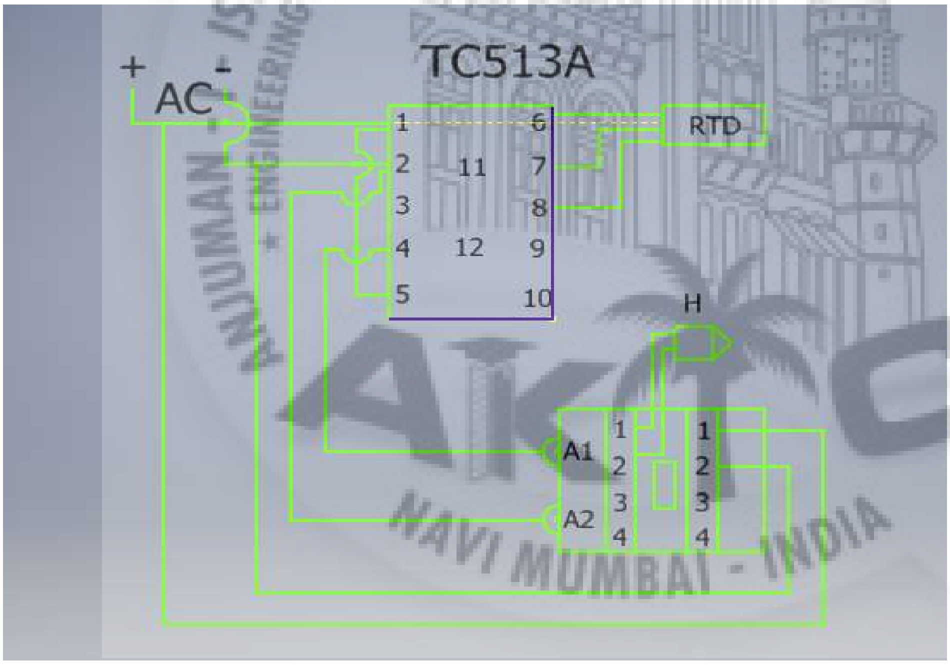

Fig 7: Electrical Circuit (Line diagram)

Fig 7shows the line diagram of electric circuit. In this the sensor is connected to on/off contactor and contactor is connected to heating plate.

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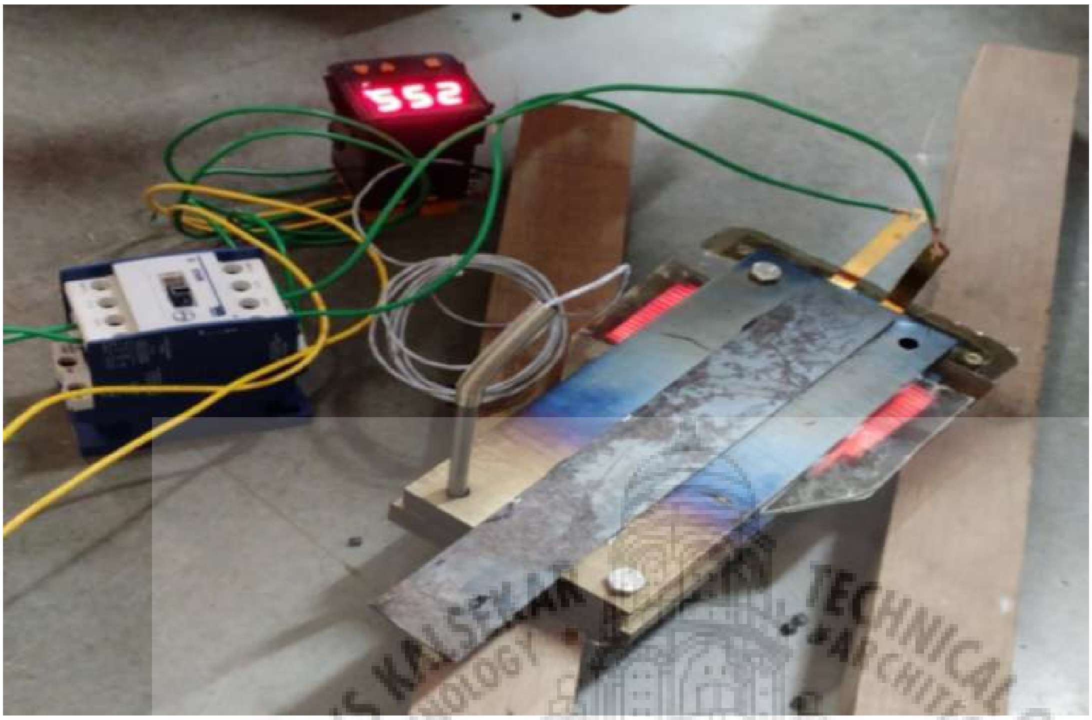

Fig 8: Electrical Circuit

Fig 8 shows the electrical circuit. In this the heating plate is below mould die and temperature is sensed by RTD (resistance temperature detector) which than further control by temperature controller.

4.3.1: EQUIPMENTS OF ELECTRIC CIRCUIT.

1. TEMPERATURE CONTROLLER (513BX).
2. RESISTANCE TEMPERATURE DECETOR (RTD)
3. ON/OFF CONTRACTOR
4. IRON COIL HEATER

TEMPERATURE CONTROLLER 513BX.

The temperature controller takes an input from a temperature sensor and has an output that is connected to a control element such as a heater or fan. ... It compares the actual temperature to the desired control temperature, or set point, and provides an output to a control element.

THE ONE WHICH WE USED IC TC513BX.

Single Display, Single Set Point Short Depth Temperature Controller, Size : 48 x 48mm [TC513BX]

Display Type	7 Segment LED Single Display
Display Configuration	3 Digits
Type of Input	Thermocouple (J,K,T,R,S) / RTD (PT100)
Resolution	Fixed 1°
Accuracy	For TC (J, K, T) inputs: 0.25% of F.S. ± 1 ° For R & S inputs: 0.5% of F.S. ±2° (20min of warm up time) For RTD inputs: 0.1% of F.S ±1°
Control Output	RELAY or SSR
Control Mode	Auto Tune / Selftune PID / ON-OFF
Supply Voltage	90 to 270V AC/DC
Size	48 x 48mm
Mounting Type	Panel Mount
Certification	CE

<u>RESISTANCE TEMPERATURE DECETOT (RTD).</u>

by using a basic principle; as the temperature of a metal increases, so does the resistance to the flow of electricity. An electrical current is passed through the sensor; the resistance element is used to measure the resistance of the current being passed through i

Fig 9: Temperature Sensor

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ON/OFF CONTRACTOR .

A contactor (fig 10) is an electrically-controlled switch used for switching an electrical power circuit. A contactor is typically controlled by a circuit which has a much lower power level than the switched circuit, such as a 24-volt coil electromagnet controlling a 230-volt motor switch.

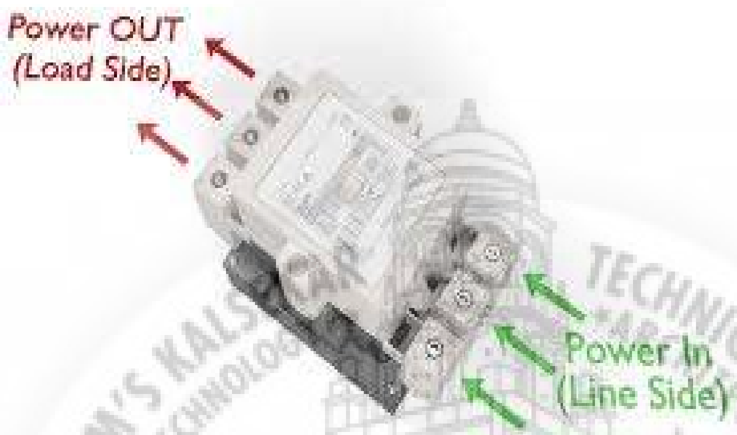

Fig 10: **ON/OFF CONTRACTOR**

IRON COIL HEATER.

A (fig 11) typical heating element is usually a coil, ribbon (straight or corrugated), or strip of wire that gives off heat much like a lamp filament. When an electric current flows through it, it glows red hot and converts the electrical energy passing through it into heat, which it radiates out in all directions

Fig 11: Heating Plate

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CHAPTER 5

TEST RESULTS

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5.1: Samples of tensile composite

Untreated Fiber   Treated Fiber NaOH   Glass Fiber   Treated KOH

Fig 12: Samples of Tensile Composite

The figure shows the output of the pneumatic compression molding machine. These samples would be used for doing tensile testing in Universal testing machine. The composites were produced by compression moulding process. Random fibre orientation was used with varied fibre content. The treated fibres were mixed with polypropylene in the moulds before taking them to compression moulding machine to produce the composites. The mixtures were heated up to melting temperature of about 160°C and maintained at this temperature for about 30 minutes which then caused them to flow in the moulds. After, cooling and solidification, the composites were separated from the moulds and were allowed to cool for 2 hours before carrying out tests on them.

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5.2:Tensile Test:

1: Stress Analysis Report of polypropylene

Physical

Material	Polypropylene
Density	0.899 g/cm^3
Mass	0.00747934 kg
Area	6381.02 mm^2
Volume	8319.62 mm^3
Center of Gravity	x=0 mm y=0 mm z=1.6 mm

Note: Physical values could be different from Physical values used by FEA reported below.

Material(s)

Name	Polypropylene	
General	Mass Density	0.899 g/cm^3
	Yield Strength	30.3 MPa
	Ultimate Tensile Strength	36.5 MPa
Stress	Young's Modulus	1.34 GPa
	Poisson's Ratio	0.392 ul
	Shear Modulus	0.481322 GPa
Part Name(s)	Polypropylene	

Force:

Load Type	Force
Magnitude	1400.000 N
Vector X	-1400.000 N
Vector Y	0.000 N
Vector Z	0.000 N

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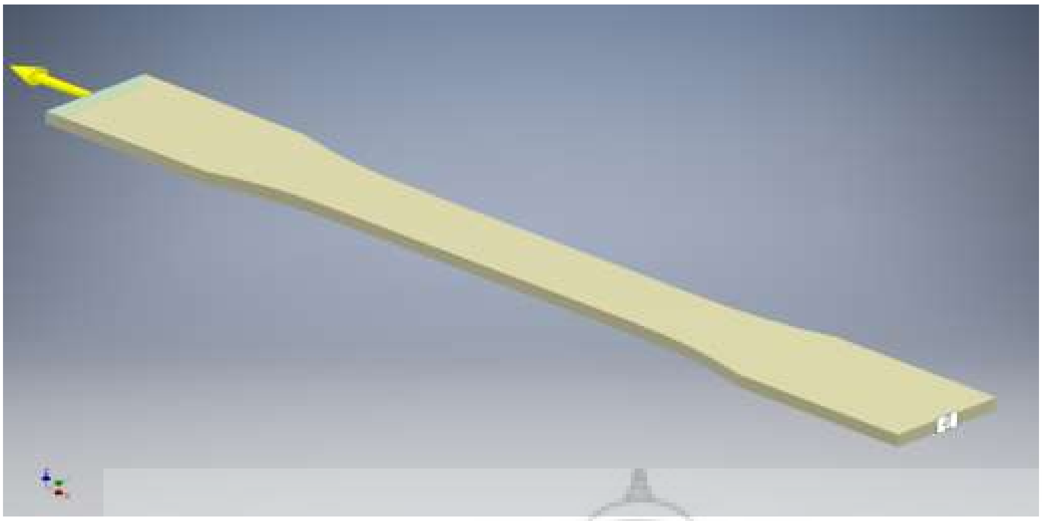

Result Summary

Name	Minimum	Maximum
Volume	8319.62 mm^3	
Mass	0.00747934 kg	
Von Mises Stress	11.634 MPa	35.5301 MPa
Displacement	0 mm	3.52534 mm
Safety Factor	0.852797 ul	2.60444 ul

Von Mises Stress

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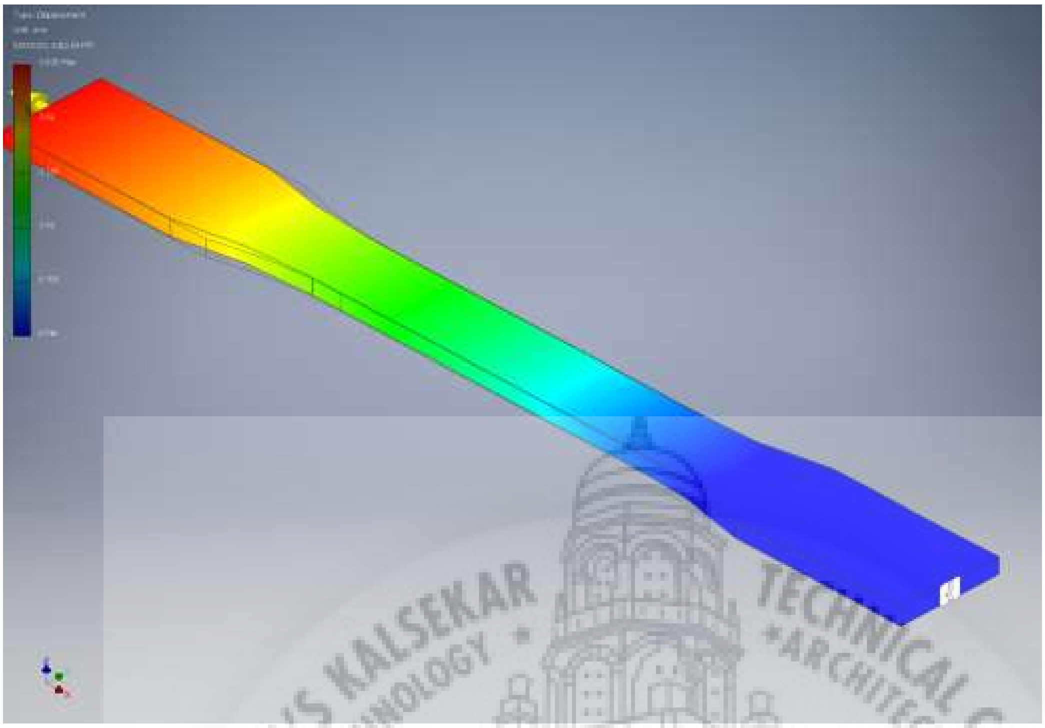
Displacement



Safety Factor

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2:Stress Analysis Report of PP- wheat straw composite

Physical

Mass	0.00580528 kg
Area	16780.5 mm^2
Volume	8319.62 mm^3

`Note: Physical values could be different from Physical values used by FEA reported below.

Material(s)

Name	Polypropylene	
General	Mass Density	0.899 g/cm^3
	Yield Strength	30.3 MPa
	Ultimate Tensile Strength	36.5 MPa
Stress	Young's Modulus	1.34 GPa
	Poisson's Ratio	0.392 ul
	Shear Modulus	0.481322 GPa
Name	Wheat Straw	
General	Mass Density	0.295345 g/cm^3
	Yield Strength	14.7003 MPa
	Ultimate Tensile Strength	14.6996 MPa

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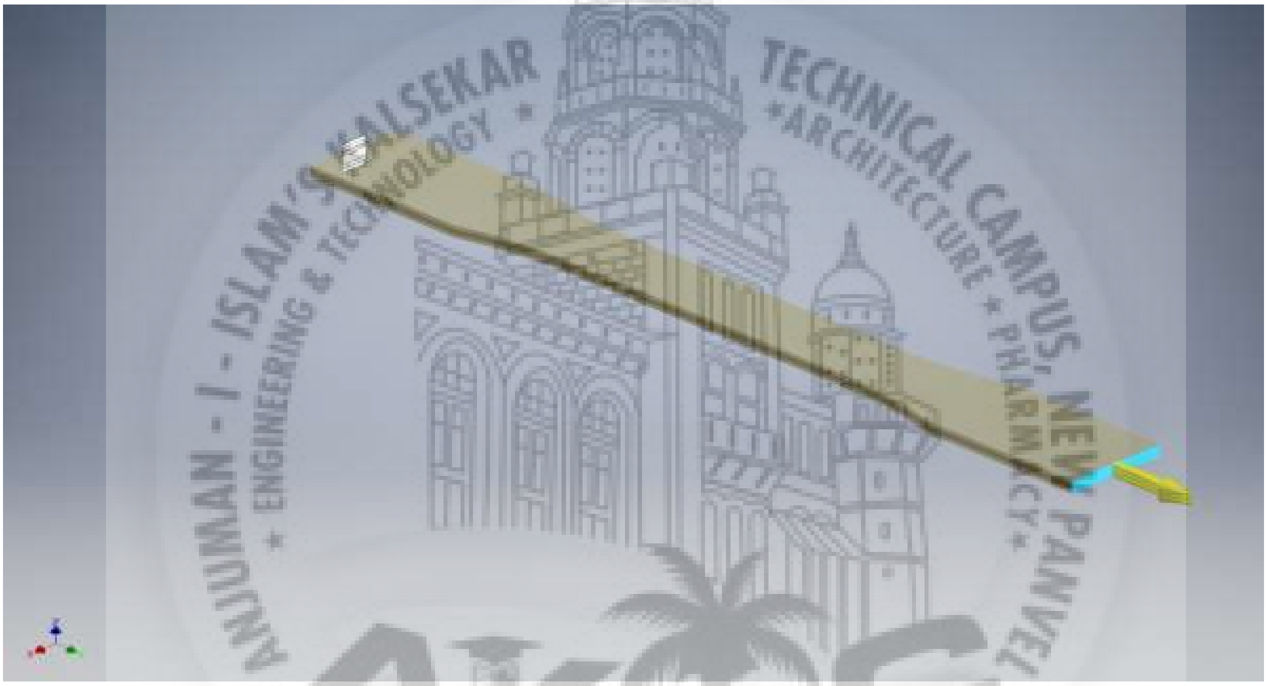
Stress	Young's Modulus	4.76 GPa
	Poisson's Ratio	0.43 ul
	Shear Modulus	1.66434 GPa

Force:1

Load Type	Force
Magnitude	1600.000 N
Vector X	-0.000 N
Vector Y	1600.000 N
Vector Z	0.000 N



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Result Summary

Name	Minimum	Maximum
Volume	8319.62 mm^3	
Mass	0.00580528 kg	
Von Mises Stress	4.64933 MPa	75.3992 MPa
Displacement	0 mm	2.20934 mm
Safety Factor	0.194966 ul	6.51706 ul

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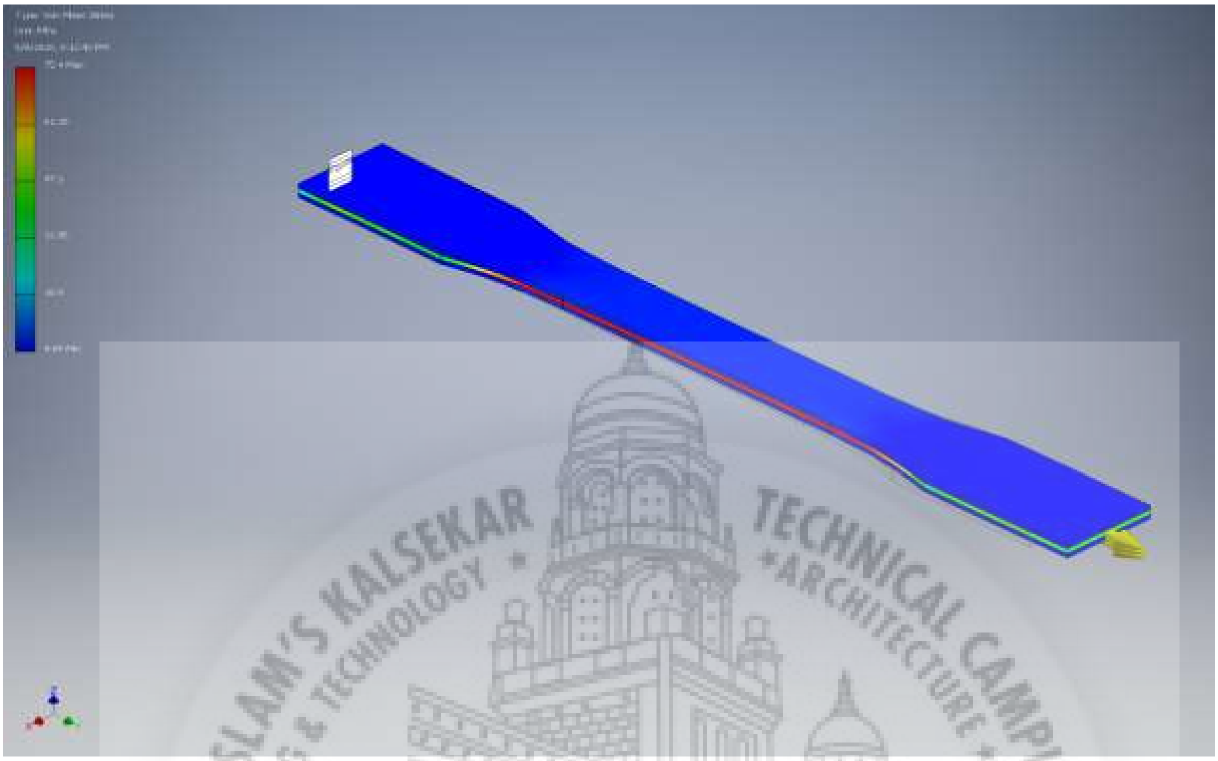
Von Mises Stress



Displacement

Safety Factor

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3: Stress Analysis Report of PP- Glass composite

Physical

Mass	0.0110318 kg
Area	16780.5 mm^2
Volume	8319.62 mm^3

Material(s)

Name	Glass	
General	Mass Density	2.18 g/cm^3
	Yield Strength	33 MPa
	Ultimate Tensile Strength	33 MPa
Stress	Young's Modulus	68 GPa
	Poisson's Ratio	0.19 ul
	Shear Modulus	28.5714 GPa

Name	Polypropylene	
General	Mass Density	0.899 g/cm^3
	Yield Strength	30.3 MPa
	Ultimate Tensile Strength	36.5 MPa
Stress	Young's Modulus	1.34 GPa
	Poisson's Ratio	0.392 ul
	Shear Modulus	0.481322 GPa

Force:1

Load Type	Force
Magnitude	280.000 N
Vector X	280.000 N
Vector Y	-0.000 N
Vector Z	0.000 N

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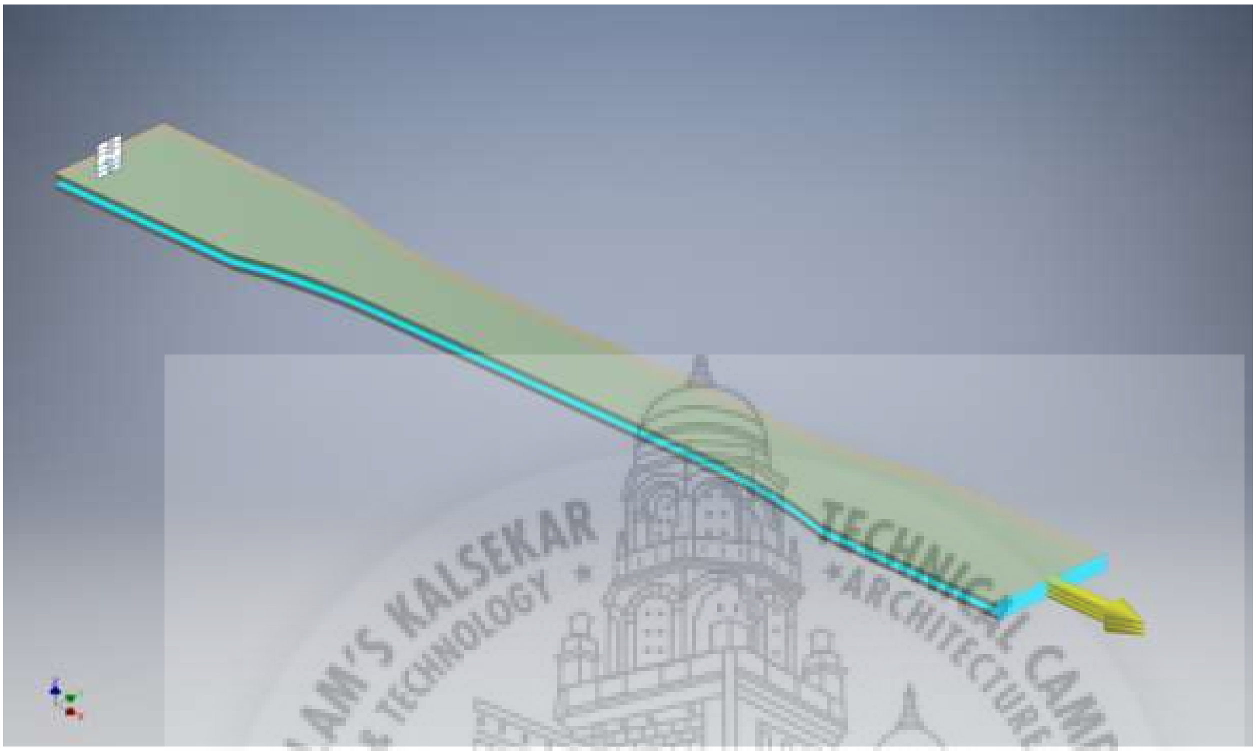

Result Summary

Name	Minimum	Maximum
Volume	8319.62 mm^3	
Mass	0.0110318 kg	
Von Mises Stress	0.0094079 MPa	37.9629 MPa
1st Principal Stress	-1.98448 MPa	38.8361 MPa
3rd Principal Stress	-13.1976 MPa	8.70951 MPa
Displacement	0 mm	7.3117 mm
Safety Factor	0.86927 ul	15 ul

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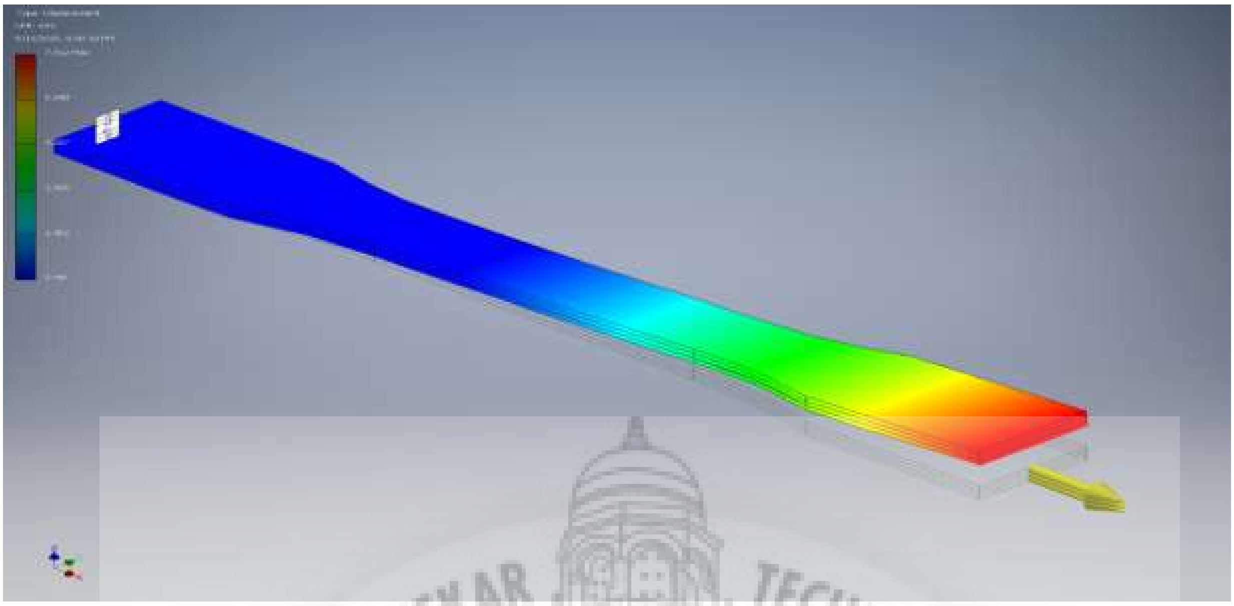
Displacement



Safety Factor

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5.2: COST ESTIMATION

SR. NO	PARTICULAR	QUANTITY	COST (□)
1	Pneumatic System	1	2731
2	Heating Plate	1	130
3	RTD Sensor	1	400
4	TC513BX	1	1130
5	Machine Structure	1	1420
6	Die Plates	2	350
7	Screw & Bolts	-	578
8	Miscellaneous	-	1200
	Total		7939

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CHAPTER 6

CONCLUSION

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6.1: Conclusion:

1. The tensile strength of the developed FRP composites are tested as per ASTM standard D-638.

2. The tensile strength of the developed FRP composites is in line with the result obtained by the other researchers.

3. FRP composite can be produced without air voids.

4. This machine can be used by the researchers for preparing FRP composites.

5.The pressures can be varied from 1bar to 6 bars.

6. Different materials can be tested for torsion testing.

7. Changing the shape of die different tests can be conducted such as Izod test, Charpy test, Brinell Hardness test.

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6.1: FUTURE SCOPE:

1. The machine can be used for making specimens of different types of testing such as Izod testing, Charpy testing , Brinell Hardness testing , etc. by changing the shape of die.

2. The machine can be further used for making different products and components by changing punch and die.

3. It can be used by researchers for conducting different experiments.

4. Small scale industries can use this machine for single or small quantity products as it is less expensive than the pneumatic molding machines that are available in the market.

5. By doing small changes it can be used as a special purpose machine for making special or single products or parts.

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