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COMPARATIVE ANALYSIS OF CUTTER CAPABLE TO CUT VARIETY OF CROPS AND ANSYS

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ABSTRACT

This comparative analysis focuses on the performance of a cutting tool designed to cut a variety of crops using materials such as AISI 1045 steel, E-Glass/Epoxy composite, High Modulus (HM) materials, and Carbon/Epoxy composite. The choice of materials is crucial in agricultural machinery, aerospace, and other industries where cutting tools encounter diverse and challenging conditions. AISI 1045 steel is a commonly used material for cutting tools, while composite materials like E-Glass/Epoxy, HM, and Carbon/Epoxy offer lightweight and high-strength alternatives. The study involves evaluating the cutting efficiency, wear resistance, and overall performance of the cutter when applied to different crops made from the mentioned materials. Factors such as tool life, surface finish, and cutting forces are considered in the analysis. The objective is to identify the most suitable cutting conditions and tool parameters for each material, ensuring optimal performance and longevity. The comparative analysis utilizes experimental testing, numerical simulations, and data analytics to assess the response of the cutter under various cutting speeds, feed rates, and depths of cut for each material. Mechanical properties, thermal characteristics, and tool wear mechanisms are taken into account to understand the material-specific challenges faced by the cutting tool. The research examines the structural integrity, thermal behavior, and wear characteristics of the cutting tool when applied to crops composed of AISI 1045 steel, E-Glass/Epoxy, HM, and Carbon/Epoxy. Finite element simulations are conducted to predict stresses, frequencies and factor of safety using ANSYS.

Keywords: Agriculture, Multipurpose machine, cutting of crops, Sugarcane, Jowar, corn

I. INTRODUCTION

The history of agriculture in India dates back to Indus valley civilization era and even before that in some parts of southern India. Today India ranks second worldwide in farm output, so there is always a need for more and more developments and innovations in the field of agricultural technology. Agriculture is the main source of income of India. Many people have agricultural lands and they use equipments which uses fossil fuel for their operation and this causes harm to ozone layer and also results in the depletion of fossil fuel for the future generation. It is important to concentrate in some aspects like how to increase productivity and profit, how to reduce waste and how to solve and ease the problems of workers. To overcome this a new manually operated crop cutter is in need of the hour. It possesses four major criterion that is ease in manufacturing, ease in handling, low cost and light weight. There are some procedures involved in fabrication of this device such as designing using Solid Edge, material and component selection and the like. The agricultural practices which are currently employed are neither economically nor environmentally sustainable and India's yields for many agricultural material are comparatively low. In the recent years we have seen a shortage of skilledlabour available for agriculture, hence due to this shortage the farmers have transitioned to using harvesters. These harvesters are available for purchase but they are not affordable because of their high costs. However agricultural groups make these available for rent on a hourly basis. Considering the Indian market, it has been noted that small holding farm owners having land less than two acres generally do not require the full-featured combine harvesters. Due to financial or transportation reasons these combine harvesters are not available in all parts of rural areas. Thus there is a need for a smaller and efficient combine harvester which would be considerably cheaper and more accessible. The mission is to create a portable, low cost mini

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harvester and user friendly. Need of agricultural tools The farming sector of India has made an essential contribution to the national economy, and its manufacturing and profitable development are crucial. As a result, farmers are under a great deal of pressure to increase their yields, and usingthe highest-quality tractors executes and tools for agriculture reduces their labour and makes manufacturing more efficient. Farming apparatus and instruments have been employed to reduce manual labour and, in turn, to produce the highest level of work effectiveness and efficacy, which was not possible using little labour. These tools may be used equally and cost affordably, which is amusing. These agricultural instruments are cheap and compatible with producers' budgets in India, so purchasing them is not difficult. These farming instruments are utilised for herbicides, nutrients, basic tilling, a fumigation and plant control. More than fifty percent of the Indian economy is reliant on the farming industry therefore, the incorporation of the finest instruments and machinery for development cannot be ignored. Nevertheless, the farming sector must be refined through the use of the highest-quality tractor tools and machinery. The farming sector is rapidly expanding, and its development and economic success are crucial to the overall economic development. Various varieties of contemporary farming apparatus and equipment are utilised in today's agriculture. Various stages of growing crops involve: primary and secondary soil preparation, sowing and establishing, farming, fertiliser application and shipping, control of pests, gathering, water supply, water drainage, transport, and storage. Managing the remnants of previous harvests, etc. Since ancient times, animals have been the mainstay of energy for demanding agricultural tasks. Eventually, steam power began to replace it. Then, gasoline-powered tractors replaced diesel engines. The use of agriculture mechanisation has resulted in a decline in the number of farmworkersin developed nations, despite a steady increase in farm output. Sachin M Moghe and et al The creation of a flywheel motor integrated into a humanpowered mini paddy harvester has demonstrated impressive efficiency in comparison to contemporary harvesters. This inventive design harnesses human pedaling as its energy source to drive the flywheel motor. The flywheel motor's capacity to store energy enhances itssuitability for propelling the mini paddy harvester. While the user pedals, the flywheel accumulates energy that can be applied to various electrical functions. This capability expands the machine's utility and versatility, enabling it to serve multiple purposes. [2] Agriculture has been transformed by technology, which has increased both the quantity and the quality of the crops. In the modern day, producers who carry out arduous duties on their farms with conventional and antiquated agricultural equipment are squandering their health and time. A tractor that was once considered an amazing invention in the agriculture sector has become ancient news. Modern farm equipment has significantly improved the agriculture sector. The combines or combo reaper, the rotavator or rotation tiller, the cultivator or plow, the farm tractor trailer, the electric harrow, the the capital, the leveler, the water-powered bowser, the ripping engineand the disc harvesting are among the most essential and often used farming machinery. Beneath is a list ofa few the most current farming equipment and their farming uses.

1.1 Need of Agricultural Cutting Machine

As it is well known that farmland serves a significant role in the financial growth of our country, there remain issues related to the cultivation of crops. Regarding the cultivation of crops, the farmer had littleknowledge of the new technologies of modern agriculture. With this type of equipment, it is crucial to boost the efficiency of farming and farming operations in order to raise yields and reduce costs,

Figure .1 . Agricultural cutting machines

1.2. Design and Fabrication of Multi-Purpose Cutting Machine for Agricultural Uses

Dr. P. G. Mehar et.al. (2022) investigated the aforementioned topic and reported that the agriculture industry in India has confronted major obstacles, including agricultural labour Not only are there deficits throughout the peak working period, but also throughout normal hours of operation. Quite the opposite, urbanisation is reducing arable land. Farming mechanisation is one method for addressing this issue. India's primary agricultural goods are peanuts, and rice, cane sugar, and maize.

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Several of those crops are discussed in detail as follows: [3] Sugar cane seedlings ought to be placed in saturated soil when growing sugar cane. This sugar cane germ is merely a component of the sugarcane cane plant. Traditionally, producers cut the complete sugar cane into five or six pieces, with two or three kernels in each piece. The cut-off portions are then planted in the soil. The residue is what remains of the Jowar and maize plant following the corn has been removed. Producers used to harvest this fibre and feed it to domesticated animals including bison, oxen, cattle, goats, etc. Pistachio constitutes one of the most important products in the entire nation. Previously, peanuts were painstakingly separated from the soil by farmers. The process is particularly labour-intensive, requiring 20 to 30 tasks per acre, and is also extremely tedious. One of India's preferred cuisines is rice. Following appears a multifunctional cutting device capable of performing a variety of operations employing creo autocad program.

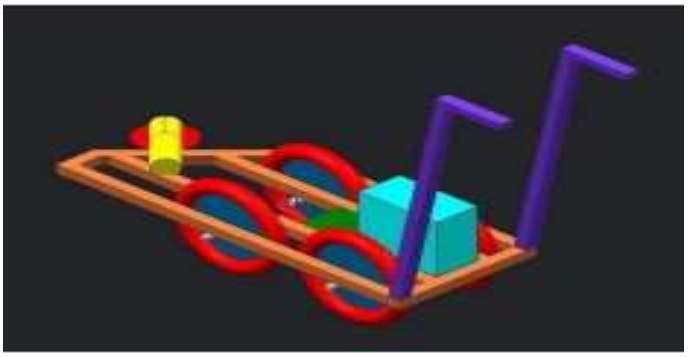


Figure 2. The 3D isometric view of multipurpose cutting machine

1.3 Properties and applications of multipurpose cutting machine Properties of multipurpose cutting machine:-

"Multi-Operational Mechanical Machine "The majority of this research was performed for the production and construction sectors. The machine that serves to manufacture the good with outstanding quality and accuracy and at a reasonable price. It decreases inventory costs. The multifunctional machinery carried out multiple operations at once with a high probability. The clutch yoke device that is directly affixed to the main motor shaft is then used for various operations. The quantity of actions executed by just one propulsion system. The primary objective of the job is to decrease energy consumption and boost efficiency while reducing space on the floor. Mobility is an essential feature of any machine in the modern era; mobility is one of the most significant technological advances in every scientific and technical discipline. The equipment that is used to manufacture the good with high quality and accuracy and at a reasonable price. It decreases the cost of inventory. The multifunctional machine carried out multiple operations at once with a high probability. A multifunctional machinery contains a blade called a hacksaw with fine teeth for chopping alloys at a rapid rate. There are both manual and electric hacksaws. The saws have movable and can accommodate a predetermined number of cuts under compression. Created and constructed a "Manually operated rotary lawn mower." This manually operated lawn mower is an eco-friendly device that employs a gear train mechanism and a bevel gear system to drive the cutting blade.A multi-operational machinery that accomplishes the task quickly and effectively can be designed if the item being worked on requires multiple tasks to be performed simultaneously but the equipment and materials are located in different areas of the facility. Pamujula Hythika Madhav and BhaskarHD,Tumkur.[4]

1.4 Different types of Cutting techniques

In India, a variety of farming tools are utilized for productive cultivation and simple farming operations. There are various types of devices used to make harvesting easier. Farms have a greater need for technologically advanced machinery and tools that make their work easier and more organised. The 'Cutter' is one of them. There are numerous varieties of cutters used for a variety of agricultural reasons, which can be categorised by their by hand, semiautomatic, and fully-automatic modes of operation. The reaper or combo combine is a flexible equipment designed to harvest produce efficiently. After integrating the three processes of harvesting, shredding, and winnowing, a harvester is produced Sugarcane Cutter A sugar slicer is commonly used for gathering. There are numerous types of sugarcane machinery intended for the appropriate gathering or trimming of dropped sugarcane harvests. Many small and portable mini harvesting machines have been developed by implement as well as farm machine manufacturers. The Mini Sugarcane Harvester is an autonomous equipment that attaches readily to tractors.The Mini Sugarcane Planter serves numerous functions, including collecting fallen sugarcane, which leveling the stalk, as well as trimming. Sugar combine combine machine is ideal for a lot of sugar cane harvesting and can operate on flat ground, whereas micro sugarcane gathering machine has become appropriate for a variety of landforms, including gentle sugar fields, mountains, and others. Harvester cutters machines are easily available with strong features and specifications. It can work for longhours of operation. The popular harvester cutter machine is manufactured by several brands such as: Kubota 488 Harvester Cutters: Kubota 488 harvester cutters is a reliable machine produced with high durability and impact resistance. It is available with categories of hole size, the length and thickness are appropriate for the perfect sharpness. Also, it is provided with one year of warranty. Application of multipurpose cutting machine: - A cutting machinery is a device used to carve different forms and products from different kinds of materials. It makes the trimming process simpler and quicker foryou. The most well-known models for are those manufactured by Circuit. This article will elaborate on the capabilities and purposes of the chopping devices. To perform

multiple operations simultaneously. To accomplish agricultural production in bulk at high volumes. To drastically decrease the time required forprocessing. To decrease labour costs. To address the issue of labour shortages.

II. LITERATURE REVIEW

Charwak1 , Mukul Kumar (2019) This paper addresses a Crop cutting Machine which is fabricated with very simple mechanisms at very low cost. Cutting of crop is one of the important agricultural operations which demand considerable amount of Labour. The availability and cost of labour during cutting season are the serious problem. The Shortage of labour during harvesting season and vagaries of the weather cause great losses to the farmers it is therefore, essential to adopt the mechanical methods so that the timeliness in cutting operation could be ensured. The use of mechanical harvesting device has been increased in the recent years. Farmers using reapers or combines to harvest their crops but these means especially combine; these are very costly making it un-affordable to most of the small farmers. Although, some manual operated reapers were developed. But, due to limitations of manual power, none of them become popular as the power available for transportation of the machine as well as cutting and conveying of the crop was not sufficient. [1] Rudolf Charles D'Souza (2017) The recently structured yieldcutting unit works without utilizing any sort of fuel or electrical vitality and can be worked with more musclepower. This gear utilizes joined sharp edges for effective yield cutting. The present structured and manufactured harvest shaper can be utilized to cut thestraws of various nourishment grain crops like Paddy, wheat and furthermore grass. It is basic in development and the working is simple. The yield shaper is really a use of unadulterated mechanical information to improve the nature of work with least work and time, extent of research in farming types of gear despite everything stays a prolific field for creative thoughts. The multifunction machine for cutting consolidates four distinct functions. By utilising this tool, the problem of work crises can be mitigated, as it speeds up the process and reduces the amount of labour needed to run the device. It performs multiple functions, so preparation time is saved. In the activity of sugar seed cutting, waste from sugarcane can be reduced and chopped seedlings are not difficult to plant. By utilising this equipment, the ground walnut harvesting process can be completed with onlytwo workers per section of land as opposed to 10 to 20 workers per section. In traditional methods, paddystripping and separating rice from plant debris are going to happen more frequently. By utilising this machine, there is going to be less waste, and rather than requiring five or six people to complete comparable duties, only two people will be required to do so in the shortest amount of time. If this equipmentis utilised by the largest amount of farmers, then ranchers will be able to overcome the problem with work catastrophes, thereby reducing the cost of the job and making the process more efficient. [2] Mr. R. A. Ghumadwar1, Mr. V. H. Bankar (2016)This title presents the concept for design and analysis of crop cutter. The crop cutting is important stage in agriculture field. Currently in India former used conventional method for the crop cutting i.e. the conventional method for crop cutting is as manually cutting using labour but this method is lengthy and time consuming.This project aim is to design and analysis of small field crop cutter machine for small height crop. To analysis cutting rollerand horizontal cutting blade by using Pro-eand anises software. The machine consists of petrol engine to operate cutting roller and blade. When compare to manual crop cutting by and this machine has a capacity to cut the crop in faster. This machine to helpful for both the small as well as big farm. [3]

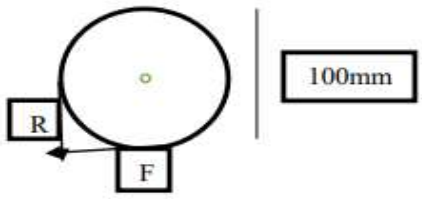
Mahesh Kadam, Shankar Thombare (2018) India is an agriculture based country which takes various types of crops. Similarly in Maharashtra millet, jowar, wheat, paddy and maize are the main crops. Now days various agricultural machines are available which are very costly .due to this it is not suitable for poor farmers. And all farmers remove crops by hands which has very effort is fully and time consuming process. Some times while cutting or removing crops by hand results into damage due to blisters on hands. Because of this the labours are not available for work, in order to overcome this situation we introduce a new simple but more efficient machine for a farmers.[4] Prof. J. P. Borude, 2warchali rohit uchappa (2017) To integrate power electronic control technology into the most mechanical mechanism of conventional internal combustion engine type has made it possible to design and implement a new electric brush cutter with blade rotation speed control and electronic circuit protection functions. The mechanical power source of tradition mechanical grass cutter is based on a two or four strokes petrol engine. To obtain some very attracting advantages such as low vibration and acoustic noise, free of air pollution and low using cost, a DC motor is used as the mechanical power source of new electric type brush cutter. In addition, a Li-ion battery and electronic control board designed for DC motor speed control and circuit protection purposes were included as well. "Personal tools" refer to tools and instruments handled by humans. Today, with the increasing mechanization of work, requirements, and industrial applications, many types and uses of personal tools are available. However, personal tools suffer from the problem of vibration. Vibrations not only weaken their performance and reliability, but also harm the worker. In this paper, we propose a model the vibration reduction, and finally perform an experiment to evaluate its performance. [5] Creation of versatile tools for farming (2020) Agriculture is India's greatest asset. Wheat and Paddy are the new agricultural focuses in which a few scientists and producers are interested. This discipline confronts several challenges, such as how to increase the advantage, improve efficacy, and reduce costs. In India, two types of gardening equipment are utilised: manual (or conventional) and motorised. Automation is the use of a device

between the labour and the power supply. Hybrid mechanisms are utilised to convert longitudinal to rotary as well as rotary to longitudinal motions. Provides a multitude of technological options, such as speed increment or decrease and speed impact. Agricultural equipment is hardware used for growing and other forms of cultivation. Nevertheless, the continuous integration of machines since the beginning of the twentieth century has madefarming considerably less labour-intensive. However, it also conserves resources and components while improving excellence, precision, and consistency. Important phases in an agricultural field include seed care, application of pesticides, and harvesting. The concept of a multifunctional agro-equipment machinery will assist farmers in reducing the costs of crop care, applying pesticides, and harvesting, as well as in extending money norms. Prof. Nitin Padghan conducted research on the Design and Fabrication of a Machine for Peeling and Cutting Corn. (2021). Due to the high cost of labor, and the associated effort, automatic floor cleaning devices have been widely utilised in wealthy countries for a long time. In nations with emerging or nascent economies, the notion is unpopular. The lack of prominence is due to the price of the equipment and the administrative expenses associated with the electricity tariff. This initiative is founded on our ability to innovate to create, develop, and produce a solar-powered, batteryoperated, or electric partially automated floor washer. This equipment serves multiple purposes. The machine in question can carry out five cleaning tasks, including refuse collection, scouring, sweeping, drying out, and dusting. A automated cleaning machine with the benefits of reduced electrical consumption and operating expenses, reduced worker effort, environmental friendliness, and simple administration. The basis of the paper's construction was the use of energy from renewable sources, which is prevalent in the majority of nations, will have a smaller environmental impact in the years to come, and is going to be simple to buildon a commercial level. Md. Tahsin Ashraf conducted study in 2020 on the topic of "Design and creation of sugar cutter for marginal and tiny farm." Agriculture is the foundation of the Indian economy. A sugarcane reaper for both big and tiny producers at a reasonable rate has been devised and developed in response to the lack of personnel throughout the harvesting period and the availability of expensive harvesters on the market (approximately 1,2 crore). The harvester's primary components included the primary frame, the diesel engine (3.73 kW), the transmission (20:1), the counterweight shaft, the front shaft, the top shafts, the blade, the handle, and the soil wheel. Using bevel gear, a sugar planter transfers force from its engine to the blade and earth wheel via the counterweight shaft, lateral shaft, and perpendicular shaft. The total mass of the harvester and engine is 60 kilogrammes. Relative to the conventional approach of harvesting, the sugarcane harvester was found to have a median effective field yield of 0.1303 ha/h and a field efficiency of 78% with minimal labour requirements of 5 man-hours per hectare. The cost for operation was Rs /ha 2067.60, which is the lowest compared to the traditional method (Rs /ha 11200), with extra savings of Rs /ha 9132, and total gathering losses of 2.69 percent for sugar harvesters.

III. METHODOLOGY

3.1 Calculation

Motor = RS 775
Voltage =24 V
Current= 1 Amp
Battery= 12V 8 AH X 2 Pcs
Connected in Series First, let's calculate the power (P) consumed by the
motor using the formula
P = V x I
Where P is power in watts (W), V is voltage in volts (V), and I is current in amperes (A). Given:
V = 24 V
I = 1 A
P = 24 V x 1 A
P = 24 W
So, the power consumed by the motor is 24 watts. Next, let's calculate the total energy stored in the batteries. The energy (E) stored in a battery can be calculated using the formula:
E = V x I x t
where E is energy in watt-hours (Wh), V is voltage in volts (V), I is current in amperes (A), and t is time in hours (h).
Given:
V = 12 V
I = 8 A (since there are 2 batteries in parallel, the total current is doubled)
t = 1 hour (assuming the batteries are discharged in 1 hour)
E = (12 V x 8 A) x 2
E = 192 Wh
RS775 – Power = 24.4 W
RS775 – Torque = 650 gm-cm
Gear Ratio Of Grinder – 4:1
Torque at output / wheel
= 650 * 4 = 2600 gm.cm = 0.26 N.m = 260 N mm
Force at teeth of the wheel



T = F * R
260 = F * 50
F = 5.2 N
Cutting Force =
Spindle Power (kW) * 48000 Cutting Speed (m /min)
5.2 N = 24.4 * 10^-3 kW

Cutting Speed Cutting Speed = 0.00469 m / min
= 0.078 mm / sec
= 4.7 mm / min
= 282 mm / hour
Blade Cutting Life Blade cutting life for cutters = 12 to 120 hoursAverage cutter life= 66 hours

Considering 30 mm for sugarcane & 25 mm for corn
1) Blade life for sugarcane = cutting speed * time Thickness of crop
= 282 * 66 30
= 620 no. of sugarcane crops
2) Blade life for sugarcane = cutting speed * time Thickness of crop = 282 * 66 25
= 745 no. of corn crops

3.2 Mechanism of multipurpose

Plastic foams has become an popular sculpting medium for artists, craftspeople, hobbyists, & machinists due to their broad availability and inexpensive cost. There are several equipment and tools available for cutting foam nowadays, but the bulk fall into one of 2 categories: portable instruments & stationary (floor or desk mounted) machines. Dr. U.V. Kongre et al Together with his team, he developed a "Multi Crop Cutter," a manually operated machine with the primary goal of expediting the harvesting process. Its key advantage lies in its ability to significantly reduce cutting time, thus conserving labor resources. Furthermore, this machine demands minimal manual effort to operate, which further amplifies its efficiency. A new type of modified cutter has been introduced, aiming to reduce dependency on manual labor and maximize profits for farmers. The objective of this work was to design modifications and evaluate the performance of a manually operated reaper. The modifications implemented in the cutter were intended to enhance its efficiency, productivity, and ease of use. By reducing the reliance on manual labor, farmers can increase their output and overall profitability. The performance of the modified cutter was carefully assessed to ensure its effectiveness in practical agricultural settings. [11] life for agriculture cutter for sugarcane Life for an agricultural cutter used for sugarcane can vary depending on several factors, including the quality of the equipment, maintenance practices, the intensity of use, and the local conditions in which it operates. Here are some key factors that can influence the lifespan of a sugarcane cutter: Equipment Quality: The quality and durability of the cutter itself play a significant role in determining its lifespan. High-quality cutters made from robust materials are likely to last longer than cheaper, less durable alternatives. Maintenance: Regular and proper maintenance is essential to extend the life of a sugarcane cutter. Maintenance tasks may include cleaning, lubrication, blade sharpening, and replacement of worn-out parts. Neglecting maintenance can significantly reduce the cutter's lifespan. Frequency of Use: The more frequently a sugarcane cutter is used, the faster it will wear out. Heavy and continuous use without proper rest and maintenance can lead to premature wear and tear. Sugarcane Varieties: Different varieties of sugarcane may require varying levels of effort and stress on the cutter. Some varieties may be tougher and harder to cut, which can affect the cutter's lifespan. Operating Conditions: The environmental conditions in which the cutter operates can impact its lifespan. Extreme weather conditions, exposure to moisture, and exposure to abrasive materials can all affect the cutter's longevity. Operator Skill: The skill and experience of the operator also play a role. An experienced operator is less likely to damage the equipment due to improper handling or misuse. Replacement Parts: Availability of replacement parts for the cutter can impact its lifespan. If replacement parts are difficult to obtain or expensive, it may be more challenging to keep the cutter in good working condition. Age of the Cutter: Like any machinery, the age of the cutter can also influence its lifespan. Older cutters may be more prone to breakdowns and require more frequent repairs. Upgrades and Improvements: Some farmers invest in upgrades or improvements to their sugarcane cutters to extend their lifespan or improve efficiency. In general, with proper care, maintenance, and reasonable use, a well-built sugarcane cutter can last for several years. However, it's essential to monitor the equipment's condition regularly and address any issues promptly to maximize its lifespan and ensure efficient sugarcane harvesting operations.

Zakiuddin K.S and et al The concept of a human-powered flywheel motor involves the integration of diverse components, including a bicycle, chain, gear pair, and flywheel. Human power has been integral throughout history, from ancient times to the contemporary era, and continues to have a pivotal role in various machines and systems. Over centuries, human power has been harnessed for a wide array of tasks, encompassing transportation and mechanical work. The efficient utilization of human energy is exemplified by the use of bicycles as a means of transport. Through the connection of a bicycle to a chain and gear system, the rotational force generated by pedaling is transmitted to a flywheel, which stores this energy for future applications. [12]

3.3 DESIGN OF THE SYSTEM

CAD means Computer Aided Design. In CAD Field there are various software like CATIA, Creo, Solid works, etc. We will be using CATIA.

- CATIA is a solid modeling program that operates on a feature-based and parametric approach. In traditional drafting, whether manual or computer-assisted, multiple views of a part are generated to describe its geometry.
- In each view, different features such as surfaces, cuts, radii, holes, and protrusions are represented, but these features are not individually specified. However, in featurebased modeling, each feature is individually defined and then integrated into the overall part.

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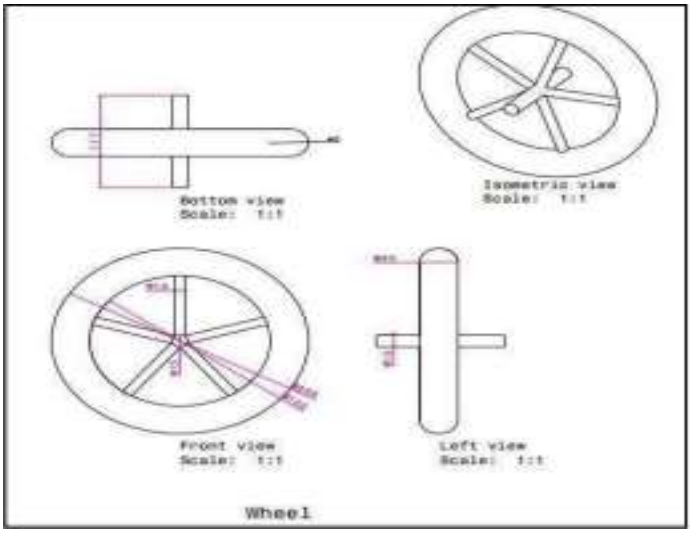
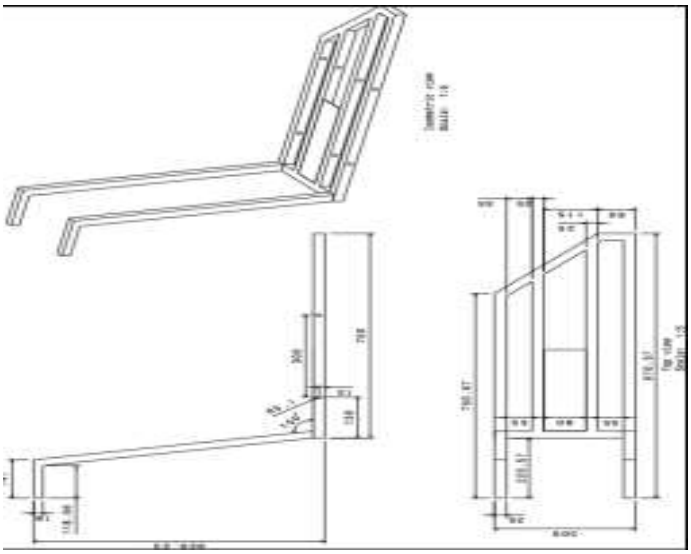
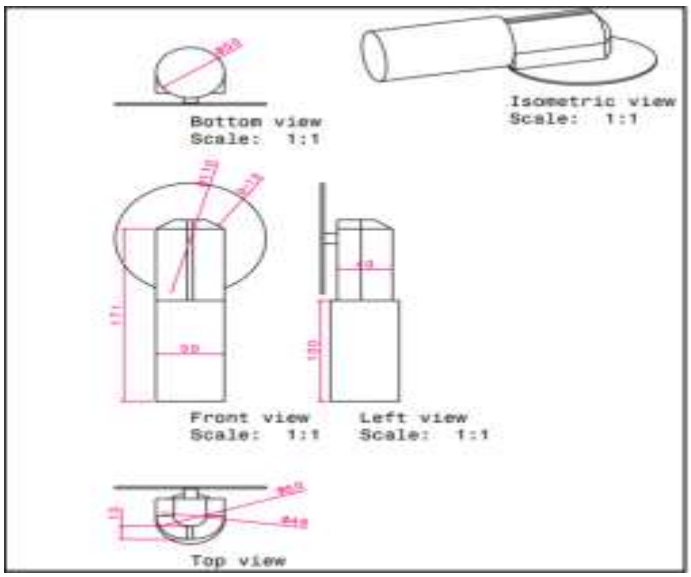
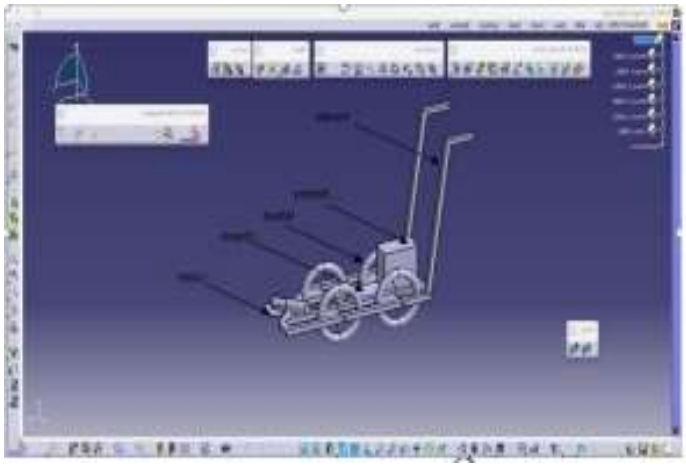
- Another important aspect of traditional drafting is that the geometry of the part is defined by the drawing itself. In order to modify the size, shape, or position of a feature, it is necessary to manually modify the physical lines on the drawing in each affected view, and subsequently update the associated dimensions.
- In parametric modeling, the features of a design are controlled by dimensions or parameters. CATIA, an engineering design software, provides a variety of tools that facilitate the creation of a comprehensive digital representation of the product being designed.
- Alongside the fundamental geometry tools, CATIA also offers the capability to create geometry for integrated design disciplines, including industrial pipe work and standard wiring definitions. Moreover, the software provides tools to facilitate collaborative development processes.









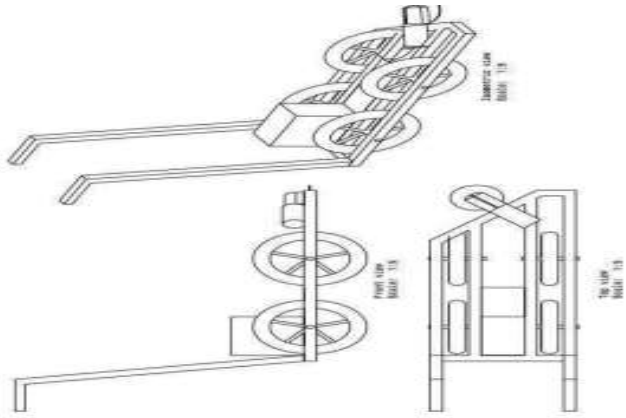


Figure 3. Dimension of Model

IV. ANALYSIS

4.1 FEA

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The finite element method (FEM) is a numerical approach used to solve engineering and mathematical physics problems. It is commonly applied in areas such as structural analysis, heat ransfer, fluid flow, mass transport, and electromagnetic potential.

4.2 Geometry

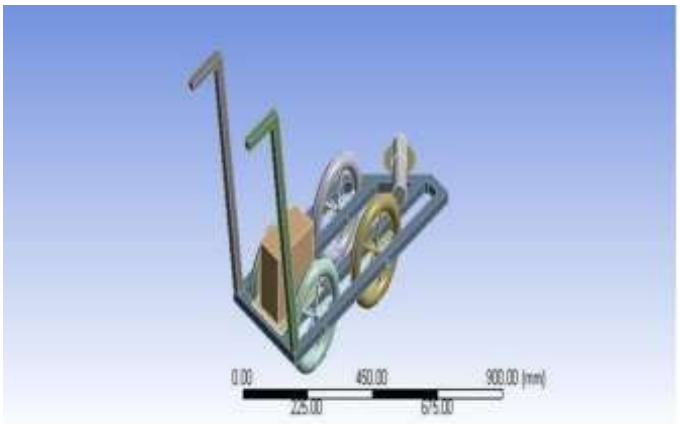

Figure 4. Geometry of Structural Steel Leaf Spring

4.3 MESH

Ansys meshing is a versatile and advanced product that others intelligent and automated capabilities, resulting in high-performance mesh generation. It is designed to produce accurate and efficient solutions for Multiphysics problems. With just a single mouse click, a well-suited mesh can be generated for all parts in a model. Additionally, expert users have complete control over the mesh generation options, allowing for finetuning. The software takes advantage of parallel processing to significantly reduce mesh generation time, minimizing waiting periods

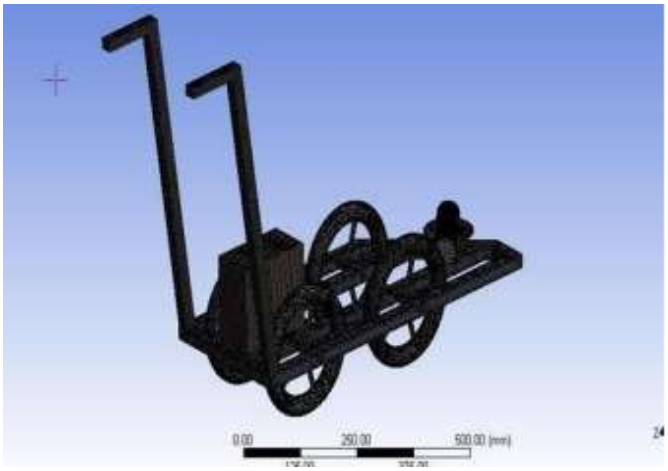

Figure 5: Meshing of model

4.4 Boundary Condition

In a model, a boundary condition involves specifying a known value for either displacement or an associated load. At a specific node, it is possible to set either the load or the displacement, but not both simultaneously. The primary types of loading available in finite element analysis (FEA) are force,pressure, and temperature. These loads can be applied to points, surfaces, edges, nodes, elements, or offset remotely from a feature.

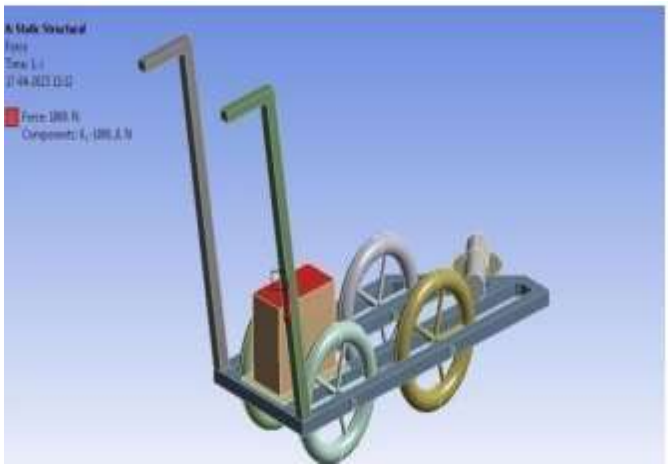

Figure 6. Boundary condition for model

Total Deformation

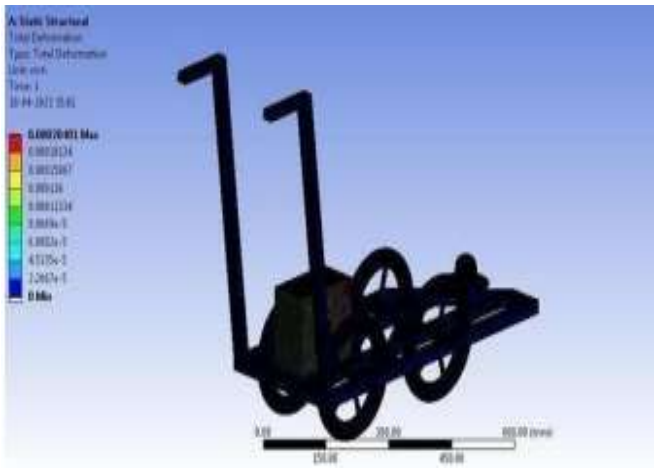

Figure 7. Total Deformation

Equivalent Stress

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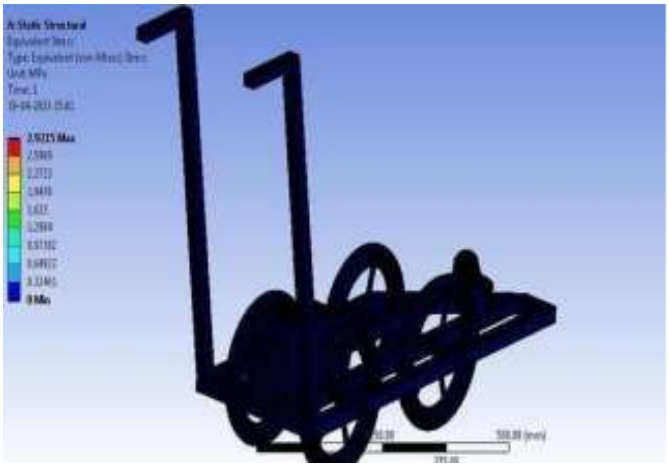
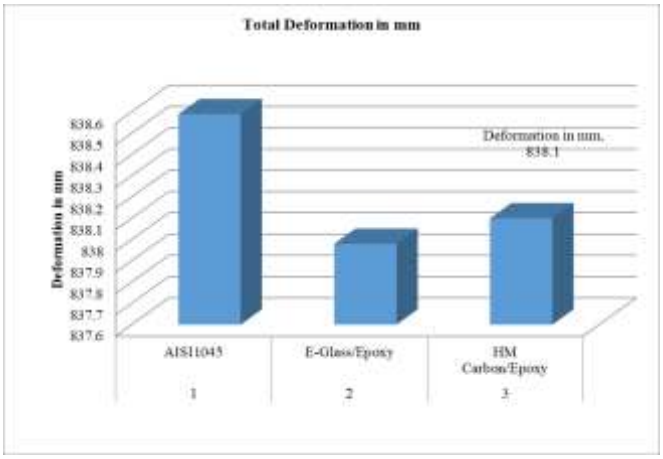


Figure 8. Equivalent Stress of model

V. Results

5.1 Total deformation

Total deformation		
Sr.No	Material name	Deformation in mm
1	AISI1045	838.59
2	E-Glass/Epoxy	837.98
3	HM Carbon/Epoxy	838.1

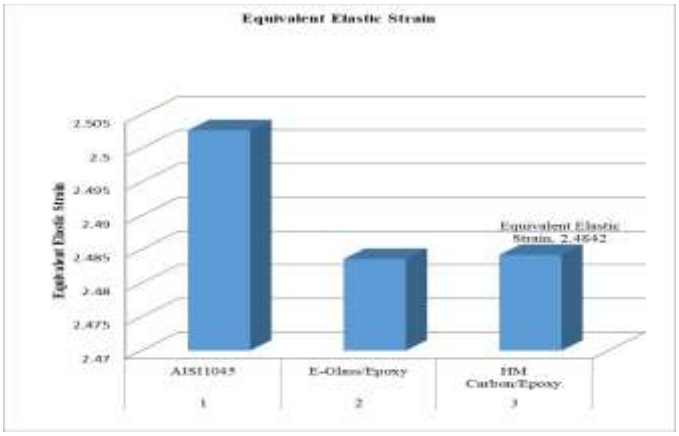


Interpretation

In above table shows total deformation for three distinct materials: AISI1045, E-Glass/Epoxy, and "HM Carbon/Epoxy." With values ranging from 837.98 mm to 838.59 mm, all three materials show comparable degrees of distortion. In materials science and engineering, measures of deformation like these are essential because they evaluate a material's capacity to bear external stresses while preserving its structural integrity. These materials may have similar mechanical qualities or be exposed to similar loading circumstances, as shown by their equivalent deformation levels.

5.2 Equivalent Elastic Strain

Equivalent Elastic Strain		
Sr.No	Material name	Equivalent Elastic Strain
1	AISI1045	2.5027
2	E-Glass/Epoxy	2.4836
3	HM Carbon/Epoxy	2.4842



Interpretation

In above table shows equivalent elastic strain data of three distinct materials' AISI1045, E-Glass/Epoxy, and "HM Carbon/Epoxy." These measurements, which are expressed in strain units, provide information on the materials' elastic deformation in response to applied stresses. When compared to the other two materials, AISI1045 shows the greatest equivalent elastic strain (2.5027), suggesting that it is comparatively more elastic. The somewhat smaller equivalent elastic strains of 2.4836 and 2.4842 for "HM Carbon/Epoxy" and E-Glass/Epoxy, respectively, imply that they would be somewhat less elastic under comparable circumstances.

5.3. Equivalent Stress Mpa

Equivalent Stress Mpa		
Sr. .No	Material name	Equivalent Stress
1	AISI1045	4.65E+05

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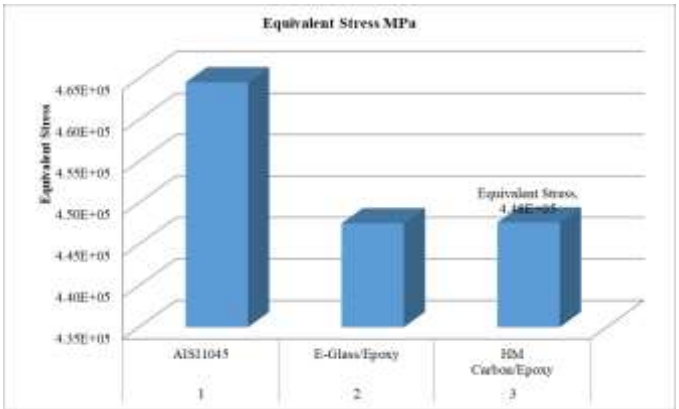
2	E-Glass/Epoxy	4.48E+05
3	HM Carbon/Epoxy	4.48E+05

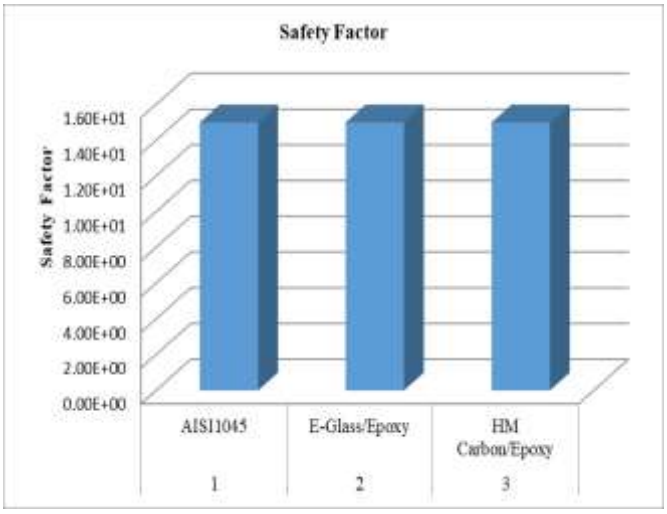


Interpretation

In above table shows equivalent stresses, expressed in megapascals (MPa), are shown in the accompanying table: AISI1045, E-Glass/Epoxy, and "HM Carbon/Epoxy." Equivalent stress levels for all three materials are comparable, ranging from 4.48E+05 MPa to 4.65E+05 MPa. This shows that both materials undergo almost the same amounts of stress under the specified loading circumstances, indicating that their strength qualities are probably similar. Such information is crucial to engineering and materials science because it makes materials more suitable for a variety of applications where mechanical strength is a crucial component by evaluating how well they can tolerate pressures and forces from the outside world.

5.4. Safety Factor

Safety Factor		
Sr. .No	Material name	Safety Factor
1	AISI1045	1.50E+01
2	E-Glass/Epoxy	1.50E+01
3	HM Carbon/Epoxy	1.50E+01



Interpretation

In above table shows Safety Factors for three distinct materials are listed in the accompanying table: AISI1045, E-Glass/Epoxy, and "HM Carbon/Epoxy." It's interesting to note that all three materials have the same Safety Factor of 1.50E+01. This consistency in the safety factor indicates that these materials are equally robust and dependable under different loading and stress scenarios. These materials can bear forces up to 15 times larger than the anticipated or estimated loads before failing, according to a safety factor of 1.50E+01. The assurance that these materials have a constant and large margin of safety makes them appropriate for a variety of applications requiring strength and durability, which is why this data is so important to engineers and designers.

5.5. Shear Elastic Strain

Shear Elastic Strain		
Sr. .No	Material name	Shear Elastic Strain
1	AISI1045	1.545
2	E-Glass/Epoxy	1.5468
3	HM Carbon/Epoxy	1.5468

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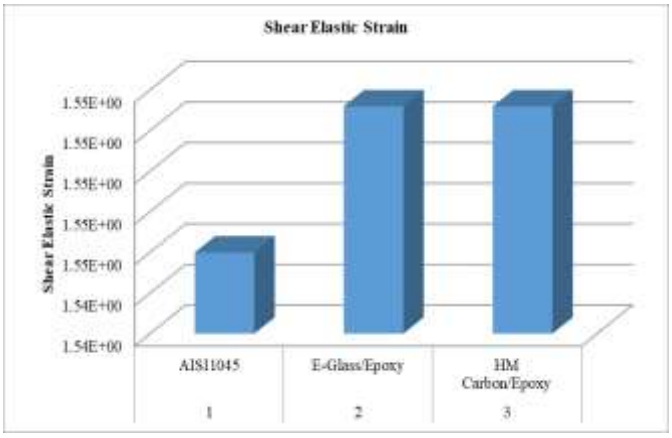
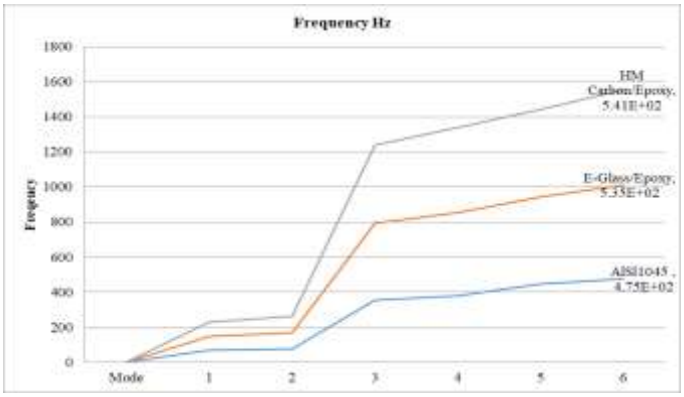


Interpretation

In above table shows Shear Elastic Strain values for AISI1045, E-Glass/Epoxy, and "HM Carbon/Epoxy" are shown in the accompanying table. Interestingly, the Shear Elastic Strain values of all three materials are quite comparable. AISI1045 measures at 1.545, while the Shear Elastic Strain of "HM Carbon/Epoxy" and E-Glass/Epoxy are both slightly higher at 1.5468. This suggests that these materials respond to shear deformation almost exactly under the given circumstances.

Total Deformation			
	AISI1045	**E-Glass/Epoxy**	**HM Carbon/Epoxy**
Mode	**Frequency**	**Frequency**	**Frequency**
1	68.359	80.539	81.74
2	77.501	90.8	92.103
3	355.51	437.75	446.01
4	3.79E+02	4.74E+02	4.84E+02
5	4.48E+02	4.94E+02	4.99E+02
6	4.75E+02	5.35E+02	5.41E+02

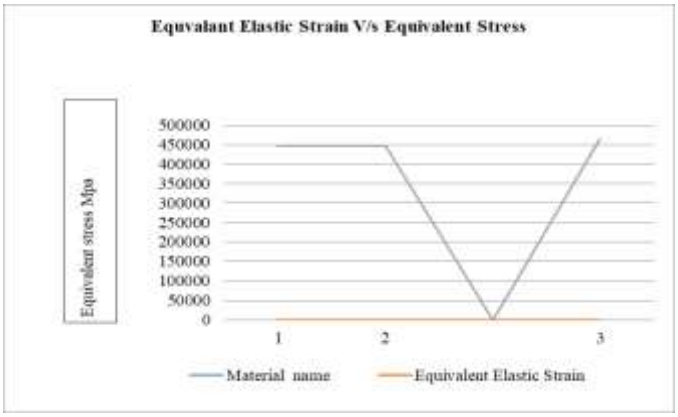


Interpretation

The table provides a comprehensive overview of Total Deformation data for three distinct materials: AISI1045, E-Glass/Epoxy, and "HM Carbon/Epoxy," across six different modes or conditions, with frequency values associated with each mode. Examining the values, we observe a consistent trend where total deformation tends to increase as we progress from lower to higher modes for all three materials. For instance, in Mode 1, AISI1045 experiences a total deformation of 68.359, E-Glass/Epoxy exhibits 80.539, and "HM Carbon/Epoxy" records 81.74. This trend continues through Modes 2 to 6, with deformation values showing an incremental rise.

Equivalent Elastic Strain V/s Equivalent Stress

	Material name	Equivalent Elastic Strain	Equivalent Stress pa
1	**E-Glass/Epoxy**	2.4836	4.48E+05
2	**HM Carbon/Epoxy**	2.4842	4.48E+05
3	**AISI1045**	2.5027	4.65E+05



Interpretation

The table provides Data on Equivalent Elastic Strain and Equivalent Stress for AISI1045, "HM Carbon/Epoxy," E-Glass/Epoxy, and four other materials are shown in the table. The E-Glass/Epoxy and "HM Carbon/Epoxy" composites measure around 2.4836 and 2.4842, respectively, and show fairly comparable values of Equivalent Elastic Strain. This suggests that the elastic deformation capabilities of these two materials under applied loads are similar. E-Glass/Epoxy and "HM Carbon/Epoxy" have comparable Equivalent Stress levels, measuring around 4.48E+05 pascals (Pa). This implies that the stress levels that both materials can tolerate before deforming are comparable. In contrast, AISI1045 has a somewhat elevated Equivalent Elastic Strain of 2.5027, suggesting a comparatively higher degree of elasticity in

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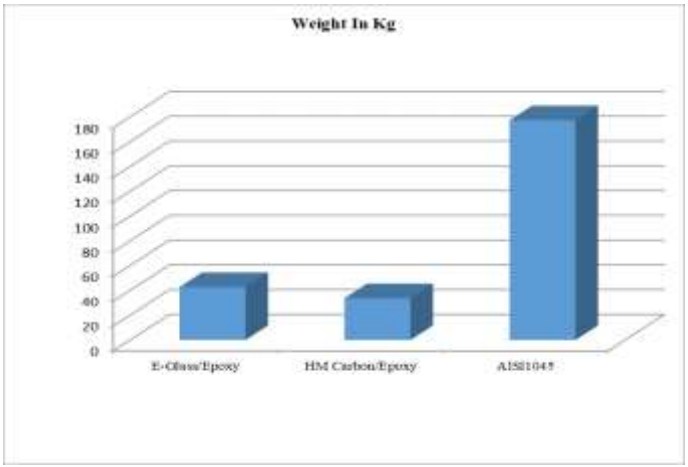
comparison to the other two materials. Furthermore, AISI1045 has a higher Equivalent Stress of around 4.65E+05 Pa,

Materials v/s Weight

Sr No	Material	Weight In Kg
1	**E-Glass/Epoxy**	42.8
2	**HM Carbon/Epoxy**	33.8
3	**AISI1045**	177.39



MATERIAL COSTING

Sr. No	Material Name	Weight (g)	Cost Per Kg.
1	**E-Glass/Epoxy**	4.28E+04	300
2	**HM Carbon/Epoxy**	3.38E+04	710
3	**AISI 1045**	1.17E+05	64-65

CONCLUSION

In the design, failure analysis, and optimization of the cutting tool using ANSYS, various materials were analyzed based on different parameters. The weights of the three distinct materials and are expressed in kilograms. The mass of E-Glass/Epoxy, measured in a standard unit of measurement, is 42.8 kg, as shown by the first item. Going on to the second item, HM Carbon/Epoxy, we discover that at 33.8 kilograms, it weighs less than the first material. The third item in the chart, AISI1045, weighs 177.39 kilograms, making it noticeably heavier than the other entries. For a variety of applications and sectors, these weight values might be essential data that helps with choices about transportation, structural factors, and material choice. In the fields of engineering, manufacturing, and construction, knowing the weight of materials is essential to guaranteeing the quality and effectiveness of projects and finished goods.

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