DESIGN AND ANALYSIS OF BICYCLE FRAME WITH VARIOUS ENGINEERING MATERIALS

[1]G. GNANAKUMAR, [2]SANTHOSH KUMAR S, [3]PRAVEEN RS, [4]PRAVEEN RJ, [5]NETHAJI M

[1]*Asst. Professor, Department of Mechanical Engineering, Panimalar Institute of Technology, Chennai, India.*

[2,3,4,5]*U. G. Scholar, Department of Mechanical Engineering, Panimalar Institute of Technology, Chennai, India.*

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INTRODUCTION

The rising cost of fossil fuels and the increasing level of greenhouse gas emissions have driven the need to find an economic and environmentally friendly means of transport. Usage of electric powered vehicles in such a context is becoming a phenomenon. Today, electric vehicles are both cost-effective and environmentally friendly. Cycling is a preferred mode of transport among people for short distances. But the major obstacle to its use is portability. Most bicycles available on the Indian market have a heavyweight steel frame instead of lightweight frames. This makes it hard to carry around. The solution to this problem is to design and build a lightweight bicycle. It provides healthy mobility by enabling riders to incorporate moderate exercise into everyday travel routines.

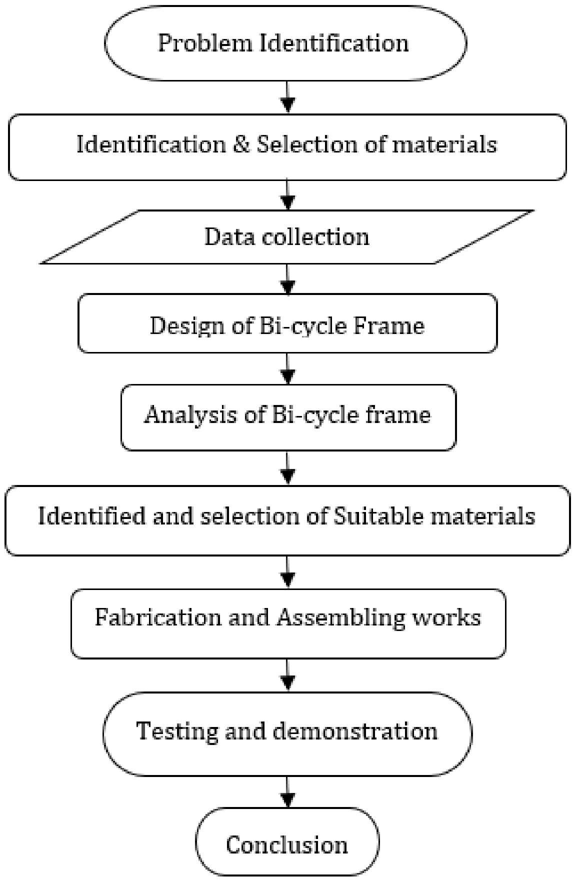
SCOPE OF THE WORKS

Transportation makes use of the combustion of fossil fuels to produce energy converted into motion. Pollution is created by unburned hydrocarbons or other elements present in the fuel or air during combustion. Combustion liberates carbon dioxide also, the primary greenhouse gas. The use of fossil fuel used in the transport industries varies widely from region to region and city to city to be comprised of all these factors. They include the information about the amount that vehicles are used in a certain country or metropolitan area; the age of the vehicle and the technology used in it; the limit to which vehicles are accurately maintained; the availability of right fuels and the extent to which they are used properly; and Atmospheric, climatological and topological conditions

AIM & OBJECTIVES

Following were the objectives decided for achieving this aim:

- To study and effectiveness of roadbike frame.
- To design and analysis of frame for roadbike.
- To provide a mode of transport which more user friendly .
- To provide mode of transport which more convenient and does not affect on the environment.
- To provide mode of transport which can use by all age group of people.
- To provide mode of transport which cleaner and energy efficient.



MATERIALS

- STEEL
- ALUMINIUM ALLOY
- CARBON FIBRE
- PET

MATERIALS: AN OVERVIEW

ALUMINIUM ALLOY

Aluminium alloys are alloys in which aluminium (Al) is the predominant metal. The typical alloying elements are copper, magnesium, manganese, silicon and zinc. There are two principal classifications, namely casting alloys and wrought alloys, both of which are further subdivided into the categories heat-treatable and non-heat-treatable. About 85% of aluminium is used for wrought products, for example rolled plate, foils and extrusions. Cast aluminium alloys yield cost-effective products due to the low melting point, although they generally have lower tensile strengths than wrought alloys. The most important cast aluminium alloy system isAl–Si, where the high levels of silicon (4.0–13%) contribute to give good casting characteristics. Aluminium alloys are widely used in engineering structures and components where light weight or corrosion resistance is required.

Aluminium alloy surfaces will formulate a white, protective layer of corrosion aluminium oxide if left unprotected by anodizing and/or correct painting procedures. In a wet environment, galvanic corrosion can occur when an aluminium alloy is placed in electrical contact with other metals with more negative corrosion potentials than aluminium, and an electrolyte is present that allows ion exchange. Referred to as dissimilar metal corrosion this process can occur as exfoliation or intergranular corrosion. Aluminium alloys can be improperly heat treated. This causes internal element separation and the metal corrodes from the inside out. Aircraft mechanics deal daily with aluminium alloy corrosion.

Aluminium alloys with a wide range of properties are used in engineering structures. Alloy systems are classified by a number system (ANSI) or by names indicating their main alloying constituents (DIN andISO). Selecting the right alloy for a given application entails considerations of its tensile strength, density,ductility, formability, workability, weldability, and corrosion resistance, to name a few. Aluminium alloys are used extensively in aircraft due to their high strength-to-weight ratio. On the other hand, pure aluminium metal is much too soft for such uses, and it does not have the high tensile strength that is needed for airplanes and helicopters.

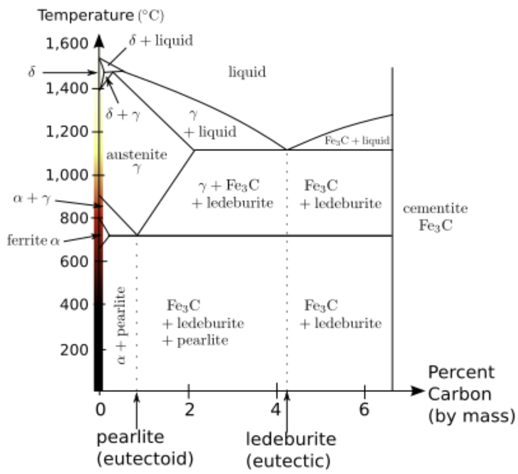
Aluminium alloys versus types of steel

Aluminium alloys typically have an elastic modulus of about 70 GPa, which is about one-third of the elastic modulus of most kinds of steel and steel alloys. Therefore, for a given load, a component or unit made of an aluminium alloy will experience a greater elastic deformation than a steel part of the identical size and shape.

STEEL

Steel is an alloy of iron and carbon that is widely used in construction and other applications because of its high tensile strength and low cost. Carbon, other elements, and inclusions within iron act as hardening agents that prevent the movement of dislocations that naturally exist in the iron atom crystal lattices.

The carbon in typical steel alloys may contribute up to 2.1% of its weight. Varying the amount of alloying elements, their formation in the steel either as solute elements, or as precipitated phases, retards the movement of those dislocations that make iron so ductile and weak, and thus controls qualities such as the hardness, ductility, and tensile strength of the resulting steel. Steel's strength compared to pure iron is only possible at the expense of ductility, of which iron has an excess.



Iron-carbon phase diagram, showing the conditions necessary to form different phases Iron is commonly found in the Earth's crust in the form of an ore, usually an iron oxide, such as magnetite, hematite etc. Iron is extracted from iron ore by removing the oxygen through combination with a preferred chemical partner such as carbon that is lost to the atmosphere as carbon dioxide. This process, known as melting, was first applied to metals with lower melting points, such as tin, which melts at approximately 250 °C (482 °F) and copper, which melts at approximately 1,100 °C (2,010 °F). In comparison, cast iron melts at approximately 1,375 °C (2,507 °F).[2] Small quantities of iron were smelted in ancient times, in the solid state, by heating the ore buried in a charcoal fire and welding the metal together with a hammer, squeezing out the impurities. With care, the carbon content could be controlled by moving it around in the fire.

Other materials are often added to the iron/carbon mixture to produce steel with desired properties. Nickeland manganese in steel add to its tensile strength and make the austenite form of the iron-carbon solution more stable, chromium increases hardness and melting temperature, and vanadium also increases hardness while making it less prone to metal fatigue.

The density of steel varies based on the alloying constituents but usually ranges between 7,750 and 8,050 kg/m^3 (484 and 503 lb/cu ft), or 7.75 and 8.05 g/cm^3 (4.48 and 4.65 oz/cu in).

Carbon Fibre

Carbon fibers or **carbon fibres** (alternatively CF, graphite fiber or graphite fibre) are fibers about 5 to 10 micrometers (0.00020–0.00039 in) in diameter and composed mostly of carbon atoms.[1] Carbon fibers have several advantages including high stiffness, high tensile strength, low weight to strength ratio, high chemical resistance, high temperature tolerance and low thermal expansion.[1] These properties have made carbon fiber very popular in aerospace, civil engineering, military, and motorsports, along with other competition sports. However, they are relatively expensive when compared with similar fibers, such as glass fibers or plastic fibers.

To produce a carbon fiber, the carbon atoms are bonded together in crystals that are more or less aligned parallel to the long axis of the fiber as the crystal alignment gives the fiber high strength-to-volume ratio (in other words, it is strong for its size). Several thousand carbon fibers are bundled together to form a tow, which may be used by itself or woven into a fabric.

Carbon fibers are usually combined with other materials to form a composite. When permeated with a plastic resin and baked, it forms carbon-fiber-reinforced polymer (often referred to as carbon fiber) which has a very high strength-to-weight ratio, and is extremely rigid although somewhat brittle. Carbon fibers are also composited with other materials, such as graphite, to form reinforced carbon-carbon composites, which have a very high heat tolerance.

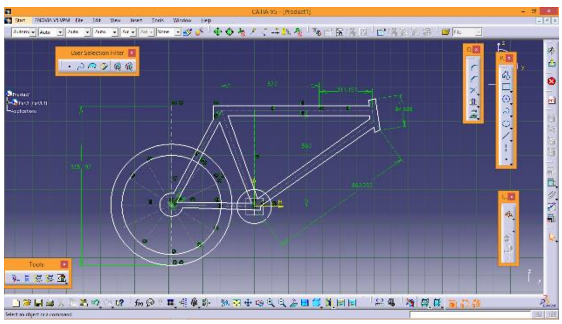
Polyethylene Terephthalate

Polyethylene terephthalate , commonly abbreviated **PET**, **PETE**, or the obsolete PETP or PET-P, is the most common thermoplastic polymer resin of the polyester family and is used in fibres for clothing, containers for liquids and foods, and thermoforming for manufacturing, and in combination with glass fibre for engineering resins. It may also be referred to by the brand names **Terylene** in the UK,

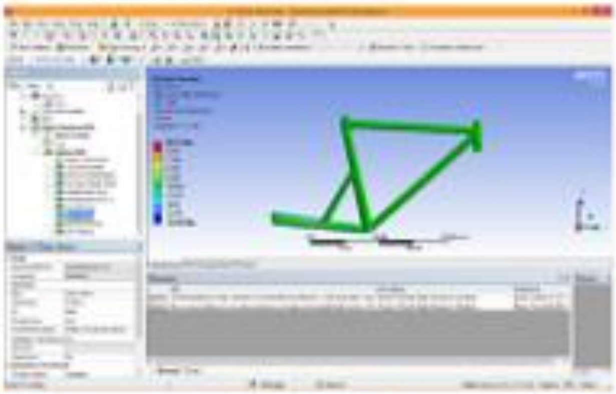
Bio-PET is the bio-based counterpart of PET. The majority of the world's PET production is for synthetic fibres (in excess of 60%), with bottle production accounting for about 30% of global demand.[8] In the context of textile applications, PET is referred to by its common name, polyester, whereas the acronym *PET* is generally used in relation to packaging. Polyester makes up about 18% of world polymer production and is the fourth-most-produced polymer after polyethylene (PE), polypropylene (PP) and polyvinyl chloride (PVC).

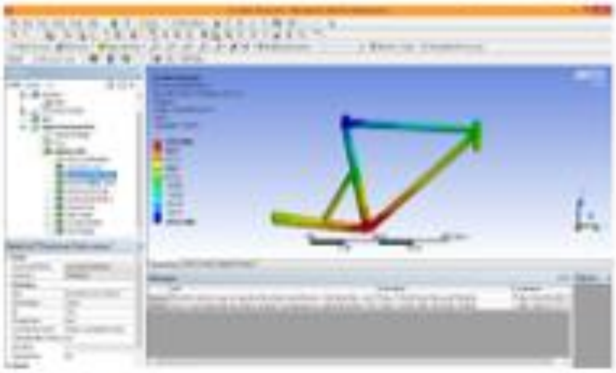
PET consists of polymerized units of the monomer ethylene terephthalate, with repeating ($C_{10}H_8O_4$) units. PET is commonly recycled, and has the number "1" as its resin identification code (RIC). The monomer bis(2-hydroxyethyl) terephthalate can be synthesized by the esterification reaction between terephthalic acid and ethylene glycol with water as a byproduct (this is also known as a condensation reaction or by transesterification reaction between ethylene glycol and dimethyl terephtalate (DMT) with methanol as a byproduct.

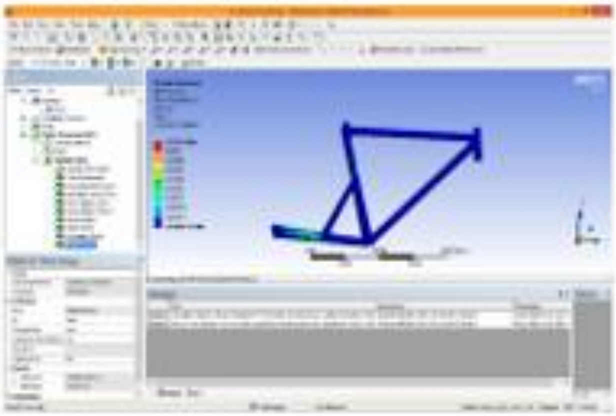
DESIGN

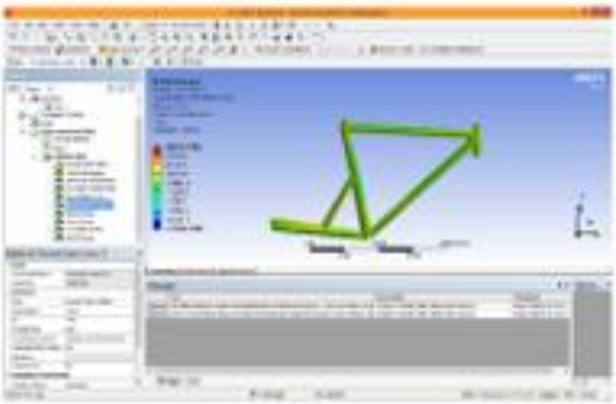


ANALYSIS









RESULT & DISCUSSION

Total Deformation

	Total deformation		
	Carbon	PET	Structural steel
50 kg	50923	46293	53830
70 kg	62959	64811	71773
90 kg	81476	83328	92883

Equivalent elastic strain

	Equivalent elastic strain		
	Carbon	PET	Structural steel
50 kg	5.99E-08	5.44E-08	5.98E-08
70 kg	7.40E-08	7.62E-08	7.97E-08
90 kg	9.57E-08	9.79E-08	1.03E-07

Normal Elastic strain 1

	Normal Elastic strain 1		
	Carbon	PET	Structural steel
50 kg	5.35E-05	4.90E-05	9.04E-05
70 kg	6.61E-05	6.80E-05	0.00012
90 kg	8.55E-05	8.75E-05	1.56E-04

Normal elastic strain -2

	Normal Elastic strain 2		
	Carbon	PET	Structural steel
50 kg	5.35E-05	4.86E-05	9.04E-05
70 kg	6.61E-05	6.80E-05	0.00012
90 kg	8.55E-05	8.75E-05	0.00012

Normal stress

	Normal stress		
	Carbon	PET	Structural steel
50 kg	14.908	13.552	25.356
70 kg	18.431	18.973	33.808
90 kg	23.852	24.394	43.752

Stress

	Stress		
	Carbon	**PET**	**Structural steel**
50 kg	16.439	14.945	13.905
70 kg	20.325	20.923	18.54
90 kg	26.303	26.901	23.993

Strain energy

	Strain Energy		
	Carbon	**PET**	**Structural Steel**
50 kg	9.06E-10	7.48E-10	8.10E-10
70 kg	1.38E-09	1.47E-09	1.45E-09
90 kg	2.32E-09	2.42E-09	2.41E-09

CONCLUSION

A novel design methodology was proposed in this investigation to maximize the bicycle energy efficiency for a driving cycle with some modification in the material of cycle frame. This method realizes a complete process from the initial parameter design of the frame to the optimal design under the real sizes with the advantages of the optimization effect, the computational efficient and fidelity calculation. The main frame design parameters are designed and optimized by the Catia and Ansys software's.

Also found from the obtained numerical investigation,

- The proposed frame is most suitable for bicycle.
- Using the results which are illustrated in the paper, the overall design is safe, effective, lightweight and reliable for the needs.
- Analysis results also prove to be much safer.
- Instead of the existing frame design, tried for various proposed frame design can be used for bicycle.

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