International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 08 | Aug 2019 www.irjet.net p-ISSN: 2395-0072

A Study on Energy Conversion with Replacing the Composite Shaft for Shaft Driven Bicycle

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ABSTRACT - There has been an increased demand for lighter bicycle components to enhance the ease of using the bicycles which require an integrated mechanical-metallurgical property analysis and validation of a given design optimization. The failure was still taking place in many cases though the dynamic results were satisfying in the design. The usage of the bicycle in a long run is an inevitable challenge as the practical conditions were not same as the design conditions. The stress levels, usage and the body weight of the person are the major parameters for the failure of the components in the bicycle. To overcome these kind of problems usage of composite materials as an alternative for the bicycle shaft and advanced technologies like Internet of Things (IOT) was an interesting choice. This project mainly focuses on the idea of use of composite shaft drive for Bicycles and the use of rapidly growing internet of things in every field of life.

Key words: Optimization, Composite materials and Internet of things

INTRODUCTION

In the present scenario, the industries are looking for the high strength to low weight materials. In that category, Composite materials are one of the promising materials in that category which provides the above major property as well addition to that strength, damping capacity, fatigue life, wear resistance, corrosion resistance and stiffness [1]. The advantage with composite materials are design feasibility, the product can produced in any number of layers, Orientation and any kind of different materials can be used [2]. The applications of these composite materials are in automotive industry and aviation industry.

IOT acts as a medium for obtaining the real time values and analysing them within a short span of time is thereby preventing a failure to happen. The main focus is on making use of IOT Technologies for the enhancement of the stress parameter affecting the bicycle. For this purpose, temperature sensor, altitude sensor, speed sensor and Arduino are used. By this we can understand the proper analysis of dynamic loading for rapid and effective part design of a bicycle. In order to reduce the weight and thus the effort required for pedalling, the steel rod is wrapped with multi-dimensional fibre-reinforced plastic strands with this mixture of epoxy and hardener. This mixture acts as a medium for holding the fibre-reinforced plastic against the rod and stress bearing capabilities with reduced weight.

In the present study, the replacement of the bicycle shafts with composite shafts to enhance the pedal capacity, lowering the weight of the bicycle in order to improve the efficiency of it.

Design Assumptions:

The following assumptions were made to design the shaft,

1) The shaft rotates at a constant speed about its longitudinal axis.

2) The shaft has a uniform, circular cross section.

3) The shaft is perfectly balanced, i.e., at every cross section, the mass center coincides with the Geometric centre.

4) All damping and nonlinear effects are excluded.

5) The stress-strain relationship for composite material is linear & elastic; hence, Hooke's law is Applicable for composite materials.

6) Acoustical fluid interactions are neglected, i.e., the shaft is assumed to be acting in a vacuum.

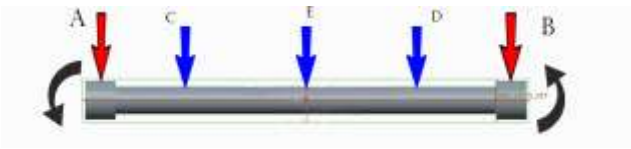
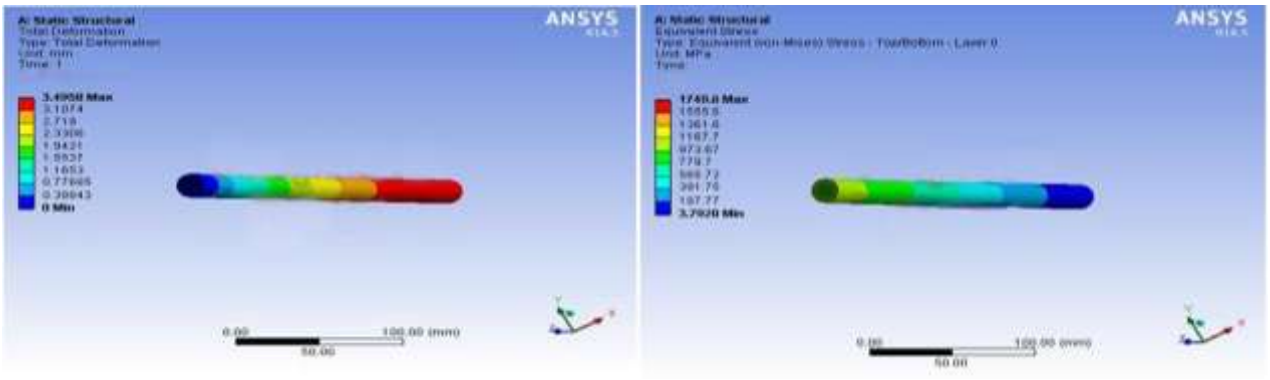


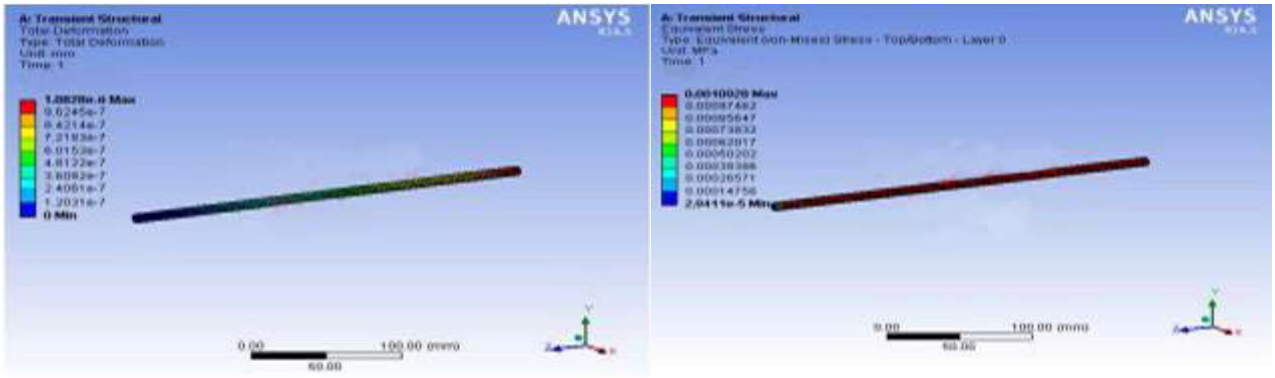
Fig 1 Forces acting on Shaft

FEA Analysis of Composite Shaft:



(a) (b)

Fig 2 Composite shaft subjected to a) Torsional Deformation b) Torsional Stress



(a) (b)

Fig 3 Composite shaft subjected to a) Dynamic Deformation b) Dynamic Stress

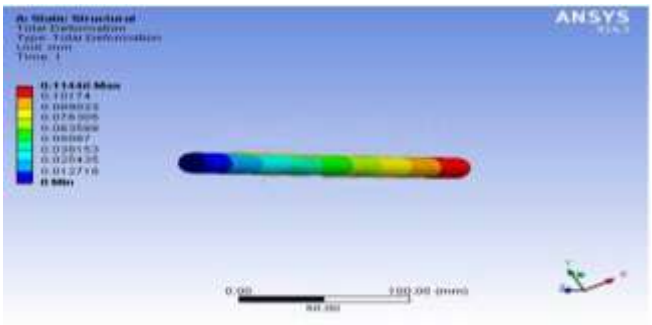


Fig 4 Composite shaft subjected to Shear Deformation

Experimental setup:

In this context, a steel rod of 13mm and multi dimensional fiber-reinforced plastic rolls are being taken. A mixture of epoxy resin and hardener are mixed in the ratios of 90ml of epoxy and 9 ml of hardener. The steel rod is being wrapped with this multi dimensional fiber-reinforced plastic strand with this mixture of epoxy and hardener. This mixture acts as a medium for holding the fiber-reinforced plastic against the steel rod. The wrapping and the application of the epoxy against the steel rod is done simultaneously. This rolling action is done until the diameter of the steel rod increases to 18mm. The ends of the rod are left without wrapping for easy weldability. The rod stuck with epoxy and fiber-reinforced plastics is the allowed to dry in the sun for about 2-3 days to get hardened. The rod thus dried is the steel rod wrapped with fiber-reinforced plastic.

Fig 5 Hand Wrapped Composite shaft

Arduino Microcontroller setup:

Arduino/Genuine Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

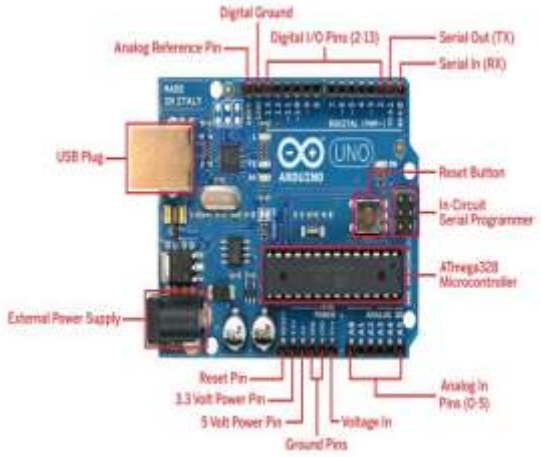


Fig 6 Arduino Microcontroller

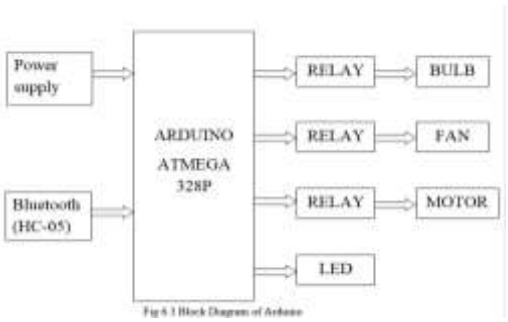


Fig 7 Block diagram of working of Arduino Microcontrol

Results and Discussions:

The present work was aimed to reduce the wastage of human power on bicycle riding. Instead of chain drive one piece drive shaft for rear wheel drive bicycle have been optimally designed and manufactured for easily power transmission. The result obtained from this work is a useful approximation to help in the earlier stage of the development, saving development time and helping in the decision making process to optimize a design. Hence we are trying to make the transmission smooth and easy by applying the bevel gears and shaft attachment instead of chain, chain sprocket. As Shaft is used for the purpose of drive, it may slightly increase the weight of the bicycle, which further increases the weight. So in order to reduce the weight of the bicycle composite is used which is able to reduce 500-600gms of weight. IoT is fast growing Field of network which has lot of future scope as it can be implemented to any field of science, social, literature, Arts etc.

FEA Results:

Table 1 Composite Shear Test (30KN)

DEFORMATION (mm)	SHEAR STRAIN	SHEAR STRESS (MPa)
0.11446	0.0015267	111.73

Table 2 Composite Dynamic Test

DEFORMATION (mm)	STRAIN	STRESS (MPa)
1.0828e-9	6.2497e-9	0.0010928

Table 3 Steel Shear Test (40KN)

DEFORMATION (mm)	SHEAR STRAIN	SHEAR STRESS (MPa)
0.6792	0.0085281	661.09

Table 4 Steel Dynamic Tests

DEFORMATION (mm)	STRAIN	STRESS (MPa)
2e-7	1.87e-9	0.0003748

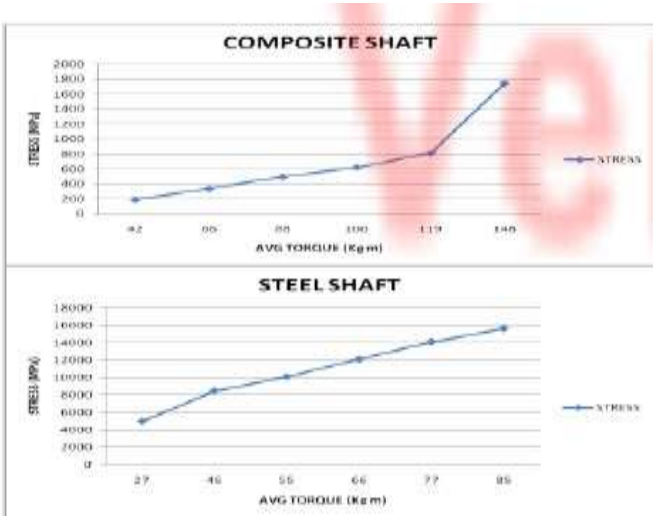


Fig 8 Comparison of steel and composite shaft

IOT Results:

Fig 9 Temperature vs Time

Fig 10 Altitude vs Time

Conclusions:

From the above project the following conclusions were drawn;

- The composite shaft was successfully designed and fabricated.
- The dynamic tests were performed and composite shaft was given the better performance characteristics than the steel shaft using the bicycles.
- Internet of things useful to be a part of the bicycle to know about the parameters like pressure, temperature, altitude and speed of the bicycle to inform the bicycle rider in case of any abrupt changes in the bicycle to pedal it him safely to destination.

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