Modeling and Fabrication of a Motorized Skateboard [MOTO-BOARD]

Abstract - Depletion of fossil fuels and increase in rate of pollution has increased the demand for electric vehicles which serves as an alternative for conventional petrol/diesel powered IC engines. In this paper we present a skateboard which runs on electric power. It was designed using solid works. The frame was made out of mild steel and a 5 inch Go-kart tyre, 12v battery was used to power BLDC motor that connects to the shafts of the wheel via a belt. The main objective of our project was to manufacture a skateboard which is cost effective and is available to anyone. Skateboard was successfully manufactured using scarp materials and thus the cost of manufacturing was reduced to less than half the price of a skateboard that is available in market. One small supporting wheel was added that accounts to the safety of the rider. This skateboard occupies less space as it is compact and hence could be used for daily commutation through modern traffic.

KEYWORDS: Skateboard, Go-Kart, 12V Battery, Electric, Steel Frame

1. Introduction

Depletion of fossil fuels and an increase in the rate of pollution has increased the demand for electric vehicles which serves as an alternative for conventional petrol/diesel powered IC engines. Electric vehicles are efficient at low-speed conditions and are pollution free. They are also helpful in preserving the present resources. Many electric vehicles have been designed to replace fuel powered vehicles. A skateboard is one of the simplest electric vehicles. They could be used for commutation through city traffic as they are less compact. In early days, skateboards were actuated by pushing with the rider's leg. But this was found to be a very tiring process and hence came up with the idea of electric Skateboard. They could also be used as an action sport for performing various freestyles.

Electric skateboard will require the rider to balance on a board and sometimes their body movement is used for actuation. The motoboard designed in this project is an improvised version of the traditional skateboard that consists only of a single wheel and an electric motor for the forward actuation. Researches on EVs are carried out in many parts of the world including China, South Korea and Japan. The developments in these fields are gaining attention worldwide.

A much comfortable and easier way of transportation for a single person would be to use a two wheeler or a skateboard. This is where the importance e of electric skateboard comes in picture. The electric skateboard is simple in design and requires only less space for commutation. They run efficiently through traffic and are easy to manufacture and maintain. The fact that there are very cheap and ecofriendly makes them preferred over any electric vehicles.

The electric skateboard is an efficient form of commutation as they are compact and requires less effort in maintenance. They emit zero emission and contribute a lot to Indian economy. No health issues are recorded so far by the usage of electric vehicles. In many ways, the electric skateboard could out power the advantages of conventional vehicles. Skateboard is small and requires minimal space to move. The rider can carry board anywhere and does not require much skill to ride one. In this Motoboard we also provide other self-balancing supports mechanisms. This can be used for straight and short distance commutations. . The motoboard designed is an improvised version of the traditional skateboard that consists only of an electric motor for the forward actuation. Skateboarding can also reduce your risk for high blood pressure, diabetes, obesity and risk for coronary heart disease.

The control of this power split by using an optimal controller is studied in **Antonio sciarretta et al. [1]** came up with an idea to develop a real-time control strategy for this power split and the main criterion to be followed was the self-sustainability of the electric path. This means that the electric energy shouldn't be recharged by an external source, rather is should be reused during vehicle operation by fuel conversion and regenerative braking system. Reusable nature of electric energy is considered in this project.

Mehrdad Ehsani et al. [2] deal with developing a propulsion system in electric and hybrid vehicles. This propulsion system also helps in reducing vehicular emission. In some hybrid system, a combination of electrical energy stored in batteries and mechanical energy available from heat engine is used to propel the vehicle. In series hybrid systems, an electric motor is used; whereas in parallel hybrid systems, torque produced by electric motor combined with torque from heat engine is mechanically coupled for propulsion.

Desna Riattama et al. [3] explains about PENS wheel, which is an electric vehicle that itself balances so that the rider will be able to stand properly without any self-balancing practice. The controller used in this electric vehicle is a PID (proportional integrated derivative) controller. A tolerance angle of 10 degree to 15 degree till angle is provided by the vehicle. The data to be used in PID controller is filtered by digital filter to reduce the effect of bias. The PID controller receives feedback from the tilt angles made and a response is being made by the motor movement to reach balanced condition

According to **Bakhtiar Ramadhan et al**. **[4],** they developed a one wheeled self-balancing electric vehicle. It is having one motor as its actuator. The sensor system uses IMU which combines gyroscope and accelerometer data to get the accurate pitch angle The main vehicle system consists of a brushless hub motor as a single actuator. The electronics and battery are placed in each sides of wheel. The gyroscope and accelerometer sensors that integrate in the IMU sensor are utilized to tilt sensor to observe the pitch angle. The internal filter calculated using DMP gives the best result, but it filter algorithm is proprietary thus cannot be openly developed

Osama Jamil et al. [5] deal with the various designs and control technologies of a two wheeled self-balancing robots. The working is based on the principle of inverted pendulum system. A kinematic model is first developed and then analyzed by dividing into two parts: wheel and frame. Many controllers were compared to find and develop the most efficient controller that allows the robot to act in real time. The system is hence in form of mathematical equations which is then analyzed using software like Simulink and MATLAB. Using many techniques, the model was tested for position control, vertical balance angle, and their control signals.

2. Materials and Methods

2.1 Selection of Material and its properties

The selection of material is an important aspect in the process evaluation, design and characterization of the design, thus the material selected in the current work alongside the properties of the materials selected is given in this section.

Mild Steel is often referred as Carbon Steel in the industry. The American Iron and Steel Institute clearly defined that the amount of carbon present in the mild steel is less than 2 percent. There are no other alloy elements present in the mixtures of Mild Steel. Usually Carbon steels are stiff and strong. The corrosion resistance for mild steel is less. When it comes to the field of welding mild steel which contains low carbon steel is one of the most easily welded metals. If the amount of carbon is increased there is a higher chance of cracking during welding.

The table – 1 gives an overview of the properties of the mild steel material used in the current work, it is seen from the table, that the properties vary for different cross section of the channels and it is maximum for a the cross sectional thickness of 25 mm, further, the yield strength also gets enhanced for the channel with a framework.

Table – 1 Property table for Mild Steel frames of different thickness

Mild Steel	10mm	12mm	16mm
Max Tensile Force(KN)	22.8	57.4	102.2
Tensile Strength (N/mm^2)	290.4	508	508
Yield Stress(N/mm^2)	233.1	376.1	349.1
Mild Steel	10mm	12mm	16mm
Breaking Force (KN)	14.7	40.35	79.7

The typical stress – strain diagram of mild steel specimen is given in figure – 1, it is evident from the figure, that the mild steel specimen exhibits a phenomenon of large plastic deformation before fracture, thus validating the fact that the mild steel is a suitable material for fabrication of the framed structure.

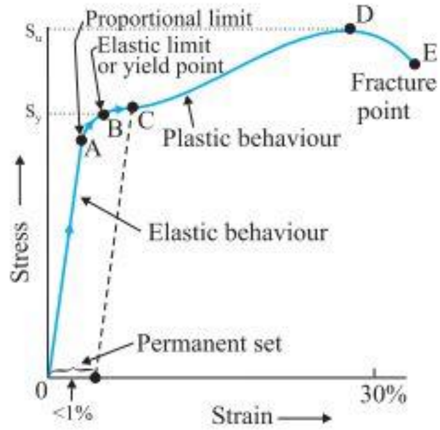

Figure – 1 Stress – Strain Diagram for Mild Steel Specimen [6]

2.2 Fabrication

The fabrication process involved cutting the channels to desired shape and dimensions to obtain the frame structure before machining and joining the channels by welding and subsequent riveting.

Initially the channels were cut to the dimensions given in the drawing by power saw machine and drilled to insert the rivets and fasten the frame, further, the shaft and the cylindrical components were turned to reduce the components to required shape and size.

After, the initial preparations of the framed structures, the channels were welded together by arc welding in accordance with the drawing and the brackets and braces were riveted. The fabricated structure was then finished by grinding the protrusions and the excess weld apart from filleting the sharp edges and corners. The finished structures is then inspected for joint strength, machining allowances provided, cut and finishing provided before the procedures of testing the frame for strength characteristics is accomplished. The geometrical dimensions and tolerances for the given components is checked and validated.

2.2 Experimental Methodology

The methodology adopted in the current work is given in the figure - 2. The methodology involved the initial process of evaluating the need for the project and carrying out the literature survey and cost estimation before selecting the design parameters and fabricated of the frame from the suitable materials selected, further the specimens are tested and analyzed for its strength characteristics.

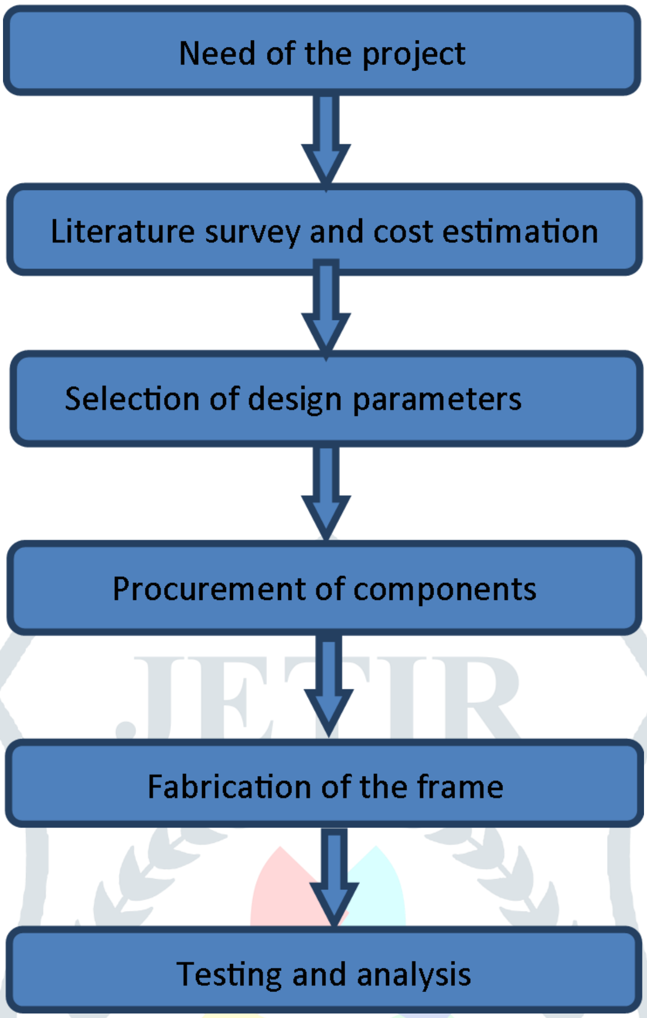

Figure – 2 Methodology of the Experimentation

2.3 Design & Analysis

The process of design and analysis involves the design of the components and subsequent import of the geometry into the ANSYS workbench followed by geometry clean up, meshing, refinement of the elements and element boundary. Further, the mesh elements are refined and the boundary conditions are applied to the elements to analyze the deformation, load and stress on the components. The elements are then discretized and evaluated. The geometry of the framed structure is given in the figure – 3.

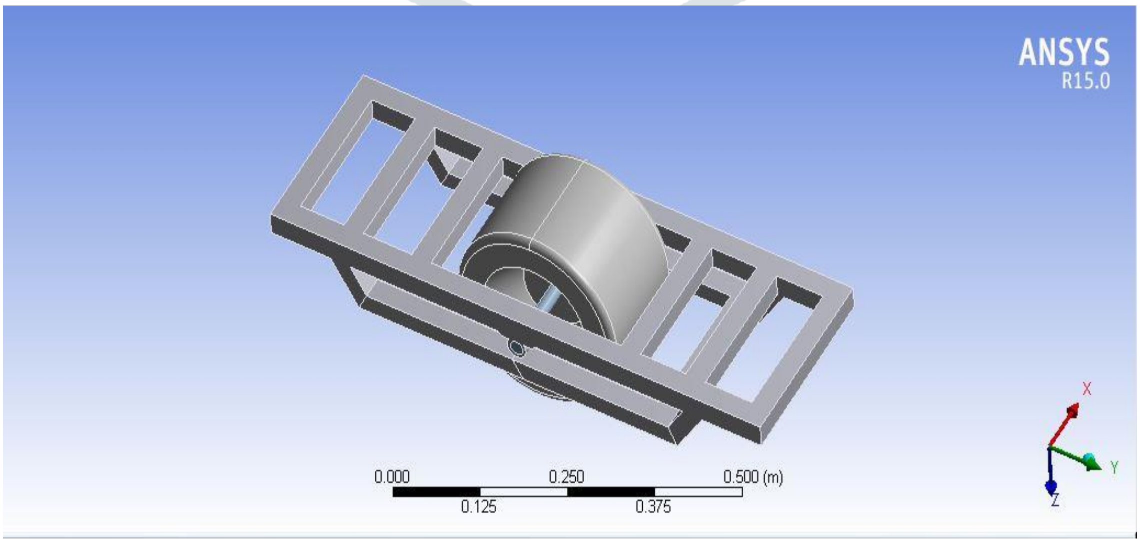

Figure – 3 Framed Structure of the Motorized Skate Board

3. Results

3.1 Von Misses Stress

The static structural analysis carried out has yielded us the following results, the equivalent von-mises stress varies from a minimum of 8.5909 e-11 to 2.5935e8 and it is maximum at the mid portion of the shaft, due to strong constraints applied by the frame and the frame mountings.

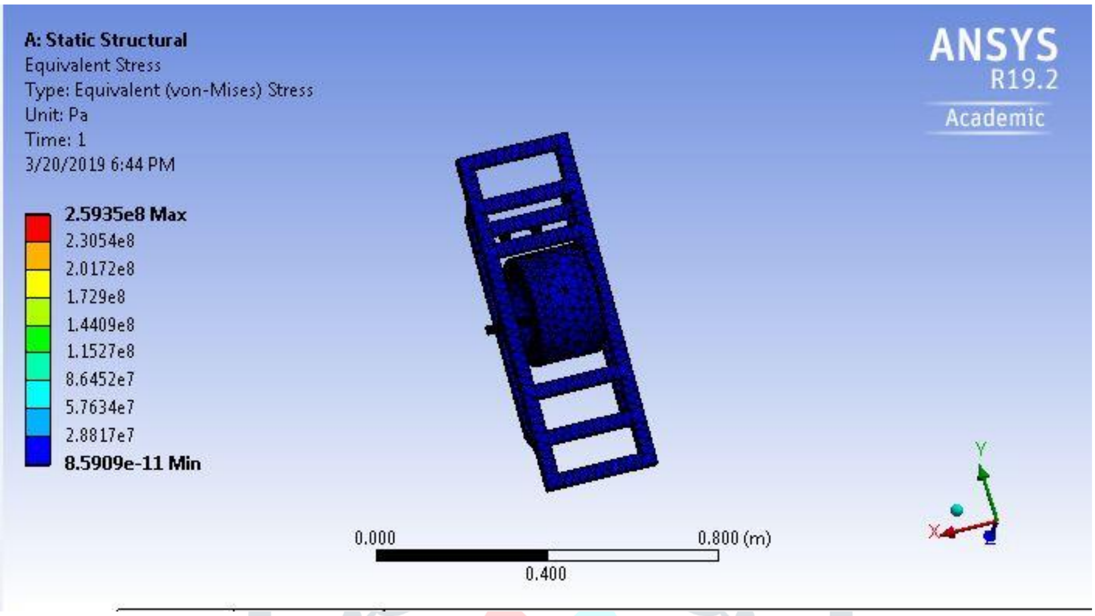

Figure – 4 Von-Mises Stress for Framed structure of the motorized skate board

The von mises stress gives the overview of yield and fracture and gives the criterion that is a result of the load and the effect of this load on the material and its yielding characteristics.

3.2 Deformation

The static structural analysis of the frame and its mounting frame is accomplished to determine the deformation, it is herewith evident from the results of ANSYS that the total deformation varies from a minimum of 0 mm to a maximum of 0.098214 mm, and the deformation is maximum at the free end where the front leg support are mounted.

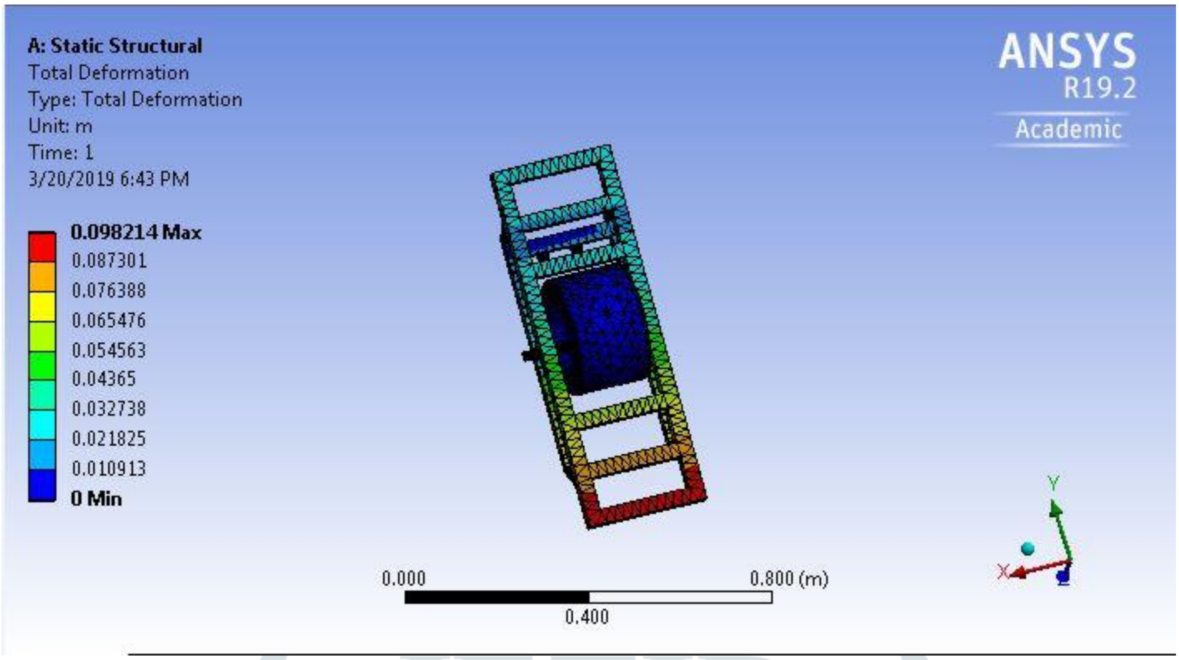

Figure – 5 Total deformations for Framed structure of the motorized skate board

3.3 Equivalent Elastic Strain of the static structural frame

The equivalent elastic strain of the static structural frame is seen in the figure , the strain value varies from a minimum of 3.4092 e-15 to a maximum of 0.42095 mm, the elastic strain is maximum inside the shaft attributed to the fact that the constraints laid to the rotating element leads to the development of strain in the shaft that leads to the deformation, however the deformation is within the limit of fracture and the limiting static value restricts the deflection.

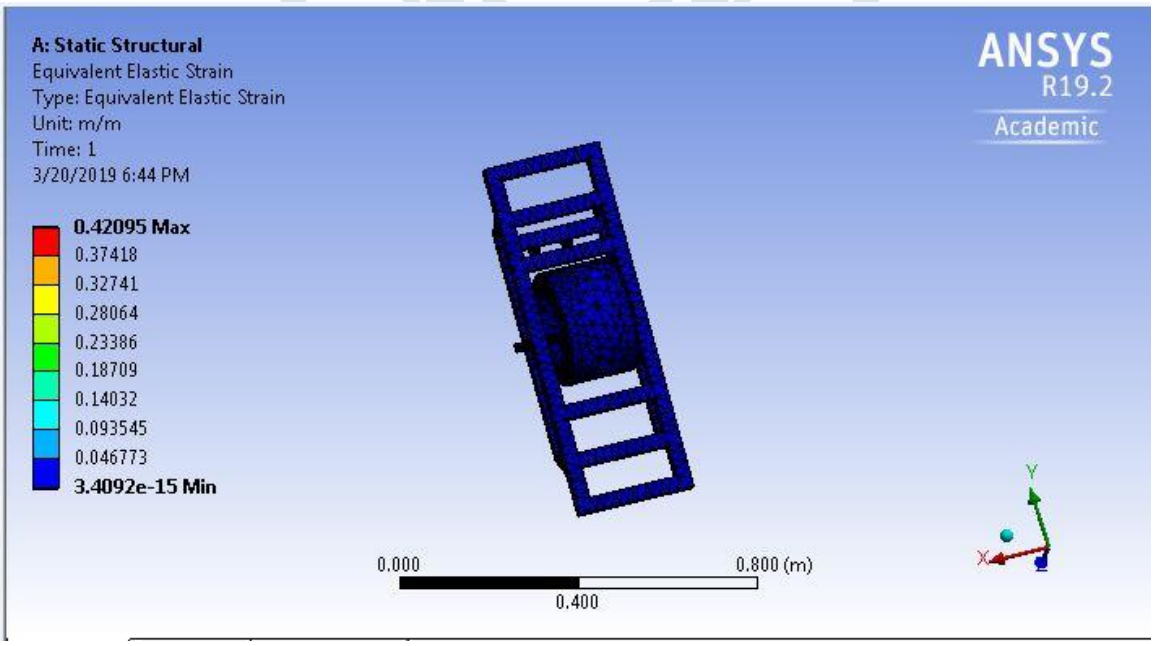

Figure – 6 Equivalent Elastic Strain for Framed structure of the motorized skate board

4. Conclusions

This motoboard is an electric skateboard which can be used in leisure time and also for easy commutation purposes. In the trend of ever increasing number of usages of electric vehicle, skateboards are more preferred for short commutation. The younger generation is considering electric skateboards an adventure sport apart from basic commutation. In this motoboard, a controller system including a resistance adjuster and a wireless connectivity module is developed. Further the following conclusions are made:

1 .The average power capacities of the existing designs are less compared to current designs.

2. The current design can take up a load of above 100kg and gives a relatively smooth ride.

3. The analytical results have yielded the following stress which is von-Mises stress of 2.593 (max) and a total deformation of 0.0982 (max) along with a strain value of 0.4209 (max).

4. The relative values obtained are incompatibility with the current design.

5. Thus the design is optimized for better performance of the motorized skateboard and is capable of running for two hours with a capacity of 12v, 30Ah battery.

5. References

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[6] Hooke's Law and Stress-strain Curve, Web URL https://www.toppr.com/guides/physics/mechanical-properties-of-solids/hookes-law-and-stress-strain-curve/