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DESIGN AND ANALYSIS OF MOTORIZED PERSONAL TRANSPORTER

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Abstract **- Cycles have come to existence from 1800's onwards and it was widely used for personal transportation ever since. Cycle usages, on the other hand, are limited when it comes too indoors. However, we need to lessen the physical effort of a person to make the ride easy and also green enough to save the environment against pollution. The objective of this work is to design, fabricate and analyse the innovative personal transport vehicle. The vehicle consists of four wheels on both sides of a frame. This system uses four wheels to increase the balancing and spacing of the vehicle. The further system consists of a horizontal platform which is driven by an electric motor and the rider comfortably stands on the platform. The vertical handlebar is used for controlling the vehicle with the help of throttle accelerator. The Battery, DC Motor and Motor controller are also used in this system. 350 Watt power of motor makes this vehicle capable of bearing the human load. The energy source required for the Segway is rechargeable batteries, which can be charged by usual AC outlets with suitable chargers. This work is deliberate to provide pollution less vehicle on campus, which is manufactured with cost reduction in mind, without compromising towards the safety and other essential features of the existing Segway. The personal transport vehicle is designed and modeled through Creo Parametric designing software and analysed through ANSYS analysis software. Since fossil fuels are depleting from the environment, the future depends upon renewable resources. The personal transport vehicle can build a hybrid. Attaching the solar panels or using any other means of renewable sources for proving energy to the personal transport vehicle. Hybrid technology will play an active role in personal electric vehicles in the future.**

I. INTRODUCTION

The transportation division nowadays has always been a challenge for many governments. The increase in the number of vehicles on the road as the years pass by keep on to increase exponentially over passing time, which leads to further pollution as well as overcrowding on roads. The introduction of an individual personal driver movable platform is otherwise known as the Segway. Dean Kamen invented this vehicle which is deemed to be a two-wheeled, with self-balancing, and battery-powered electric vehicle plays a significant role in the system. The main necessities of segway vehicle are that it creates emissions-free; turning radius was zero and has a secure traveling speed. The personal electric vehicle (PEV) appears as a novel tool for the transportation sector in the before the 1990s. PEVs carrying an individual traveler towards a trip distance of around 1Km to10 km and utilize electricity as the cause of energy source. The PEV is usually exposed to the variable weather conditions and used to operate at below than the highway speeds on neighboring roadways and along the pathway. This group of the vehicle mainly belongs to electrically operated scooters and cycles. Well known existing companies such as Yamaha have come into this type of vehicle as a good initiation towards this Segway. It has a single flat platform and two wheels on its sides, which are operated mainly by an electrically operated motor power and the rider could locate on the platform. Further, it has a vertical handlebar for controlling its direction. The first and foremost objective is to control and maintain the vertical balance of the structure and avoids the vehicle and riders collide. This aim is to convene by gyroscopic velocity and also through angle sensors. This system reacts well to the rider's instructions and travel to the preferred point. Because of this, the rider can move frontward or rearward by changing their weight frontward or rearward on the platform. The power resources of Segway are rechargeable batteries can be charged by common AC power with suitable chargers. DC motors are used due to their easy adaption and function towards batteries. Equally wheels and motors are placed on each side of the platform. Generally, while the rider is on the platform and system is on to maintain the balance and prevent a collision. This job is done by use of electromotive force to the wheels with DC motors.

In this work, an attempt was made to design and fabricate the personal transporter with four wheels. For this system in order to reduce the load distribution among the wheels below the platform and increase the stability compared to the two wheels, without any interruption during the motion.

II. DESIGN CALCULATIONS

SELECTION OF THE MOTOR

A DC motor with the gearbox is selected based on the application of personal transport vehicle.

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POWER OF THE MOTOR

- Power of the motor, P = 2πNT / 6000
- Speed of the motor, N = 3000 rpm
- Torque Produced, T = 1.20 N-m

Therefore, the power of the motor

- P = 2π × 3000 × 1.20 / 6000
- P = 0.376 KW

Or

- P = 376 W

SELECTION OF THE SPROCKETS

- No of sprocket teeth, n = 40
- Chain pitch, p = 0.510 mm
- Sprocket diameter, d = 161.798 mm

STRESS ACTING ON THE BASE

- Weight of the user = 80 Kg
- Weight of the personal transporter = 25 Kg
- Total Weight, W = Weight of the user + Weight of the personal transporter
- W = 105 Kg
- Load acting= Total Weight × Gravity
- Gravity, g = 10 m/s
- Thus, load acting P = W × g = 105× 10
  P = 1050 N
- Area of base = 457.2 × 330.2
  = 150967.44 mm^2
- Stress acting on base = 1050 / 150967.44
  = 6.95×10^{-3} N/mm^2

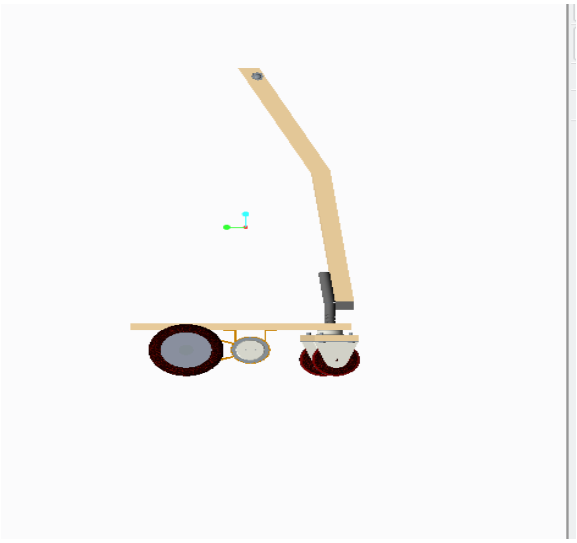
YIELD STRESS

- Max weight on base = 130 kg
- Yield stress = Maximum weight × gravity / Area of the base
- Yield stress = (130 ×10) / 150967.44 Yield stress = 8.611×10^{-3} N/mm^2

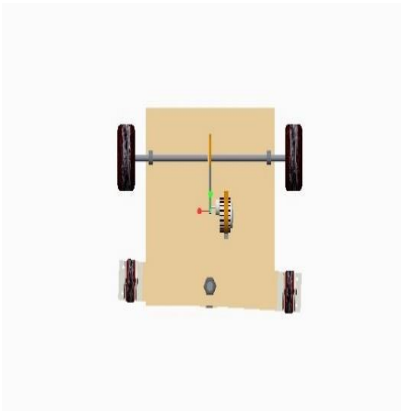
FACTOR OF SAFETY

- FOS = Ultimate stress / Allowable stress
- FOS = 1300/1050
- FOS = 1.52 ~ 2

FRONT VIEW



SIDE VIEW



BACK VIEW

DESIGN OF THE PERSONAL TRANSPORTER

The different types of views of the personal transporter are designed and modeled in CREO Parametric design software. These views were presented here in order to make a clear view before manufacturing of the personal transporter.

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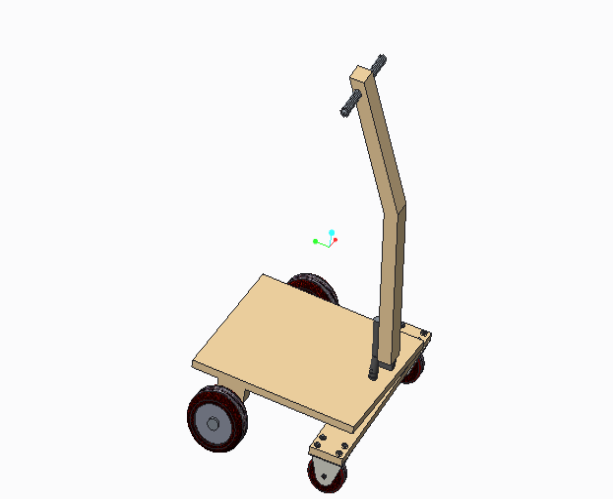

TOP SIDE ANGLE

FRONT SIDE ANGLE

FABRICATION OF THE PERSONAL TRANSPORTER

The components used for fabrication of the personal transport vehicle are:

- Pillow bock bearing;
- Sprocket and chain;
- Thrust bearing;
- DC Motor;
- Wheels and
- Handle setup.

PILLOW BLOCK BEARING

Initially, the wood riding platform is selected of cross-section 2x2 feet. The bearings such as pillow block bearing and thrust bearing are used in this fabrication. The pillow block bearing is placed on either side of the backside of the wooden base. This bearing allows the shaft to pass through it. The back wheels are fixed with the nuts and bolts.

SPROCKET AND CHAIN

The sprocket is placed in the middle of the shaft. A small piece of pipe is welded with the sprocket. Then two holes are drilled in the shaft then the pipe is fixed with the shaft. Certain ground clearance is needed because of the sprocket placed. Therefore, plastic fiber is placed below the pillow block bearing for the clearance. This material does not get compressed when acted upon force.

THRUST BEARING

The dc motor is connected to the motor controllers. Then the thrust bearing is placed on the front of the base. Then the wooden piece is again placed upon the thrust bearing. Then the wheels are added to the sides of the front side. Again the ground clearance is checked, as to provide enough clearance for the movement of the vehicle.

DC MOTOR

The dc gear motor is placed on the center of the wooden base. The dc motor is being fixed with the clamp connected with nuts and bolts. Then the chain is connected with the sprockets and the gear motor.

WHEELS

This vehicle is fabricated in the way where four wheels are placed on all side of the base. The wheels are mounted upon the base secured with the nuts and bolts.

HANDLE SETUP

A handlebar is placed upon the front side of the base. The handle is manufactured in the shape where it does not disturb the rider while standing and be comfortable for them. A hole is drilled at the top of the wooden handle then a pipe is inserted to it. The throttle is fixed with the pipe that is bored upon the handle. The throttle is connected to the motor controller, where the speed increasing and decreasing can be directly connected and also for applying the brake. The battery is recharged from which the power tends to transmit to the dc motor and also for the dc controller.

FABRICATED MOTORIZED PERSONAL TRANSPORTER

The motorized personal transporter is fabricated using the above-listed components and shown in the figure below. Both the bottom and the front view were presented to know the fabrication part of the transporter evidently.

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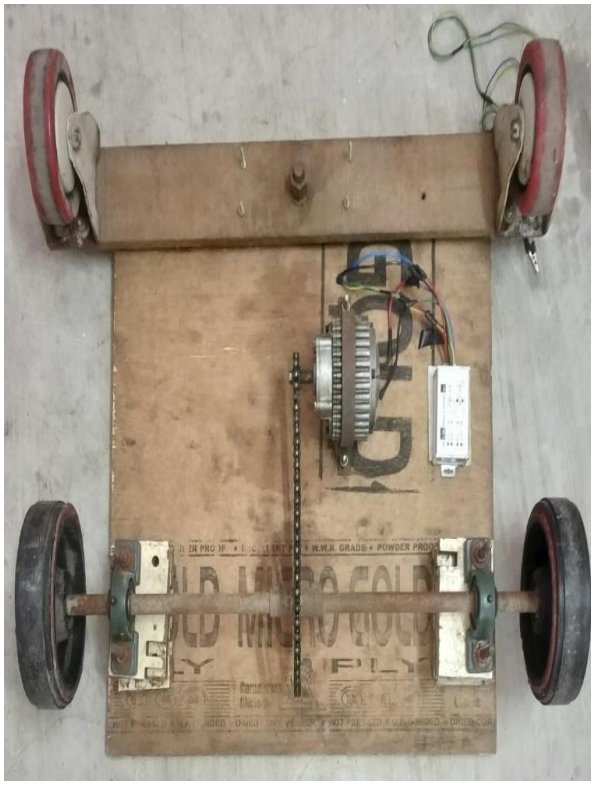
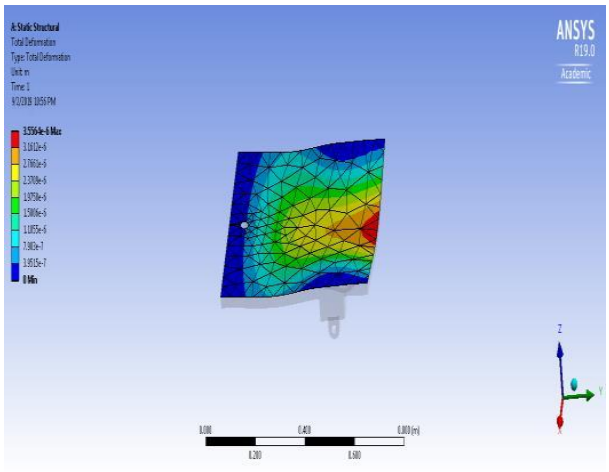


BOTTOM SIDE VIEW OF THE BASE

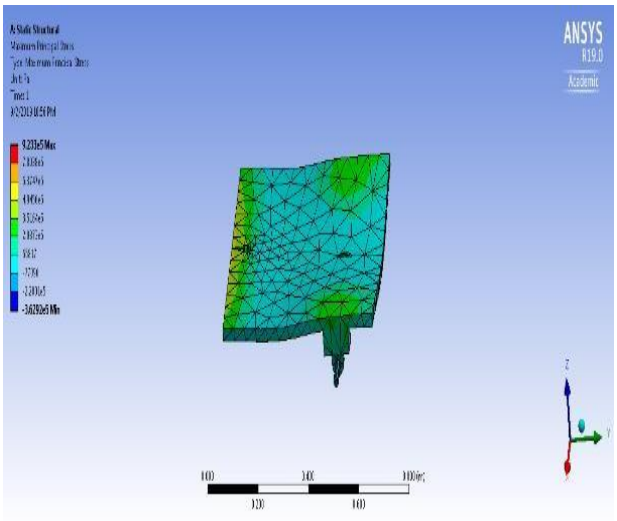
FRONT SIDE VIEW OF THE PERSONAL TRANSPORTER

ANALYSIS OF THE BASE

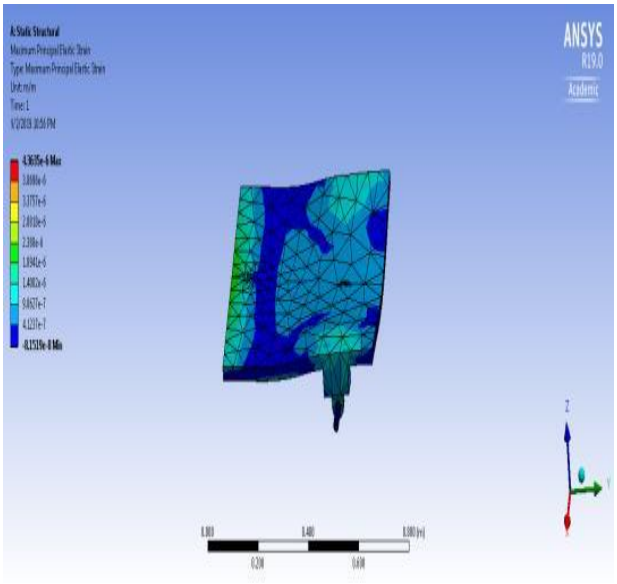
The base of the personal transport vehicle is analyzed for various loads acting on it. The analysis is done by using ANSYS analysis software



TOTAL DEFORMATION



MAXIMUM PRINCIPAL STRESS



MAXIMUM PRINCIPAL ELASTIC STRAIN

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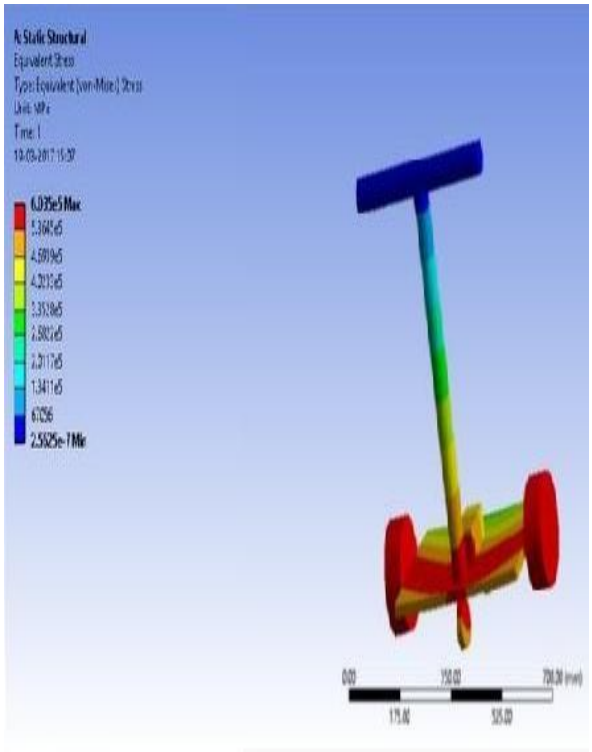
III. RESULTS AND DISCUSSION

The personal transport vehicle is designed and modeled in CREO Parametric designing software and then fabricated. The load analysis test has been done for calculating the strength of the base platform using ANSYS analysis software. It was evident from the total deformation, maximum principal stress and maximum principal elastic strain analysed. Now it efficiently runs and satisfies the needs of the requirement. The vehicle is technically feasible with great stability and smooth transition.

From the journal "DESIGN AND FABRICATION OF BATTERY POWER OPERATED SEGWAY", International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE) Vol. 3, Special Issue 9, March 2017 the result of the old two-wheeled model of the Segway is obtained.



STRESS ANALYIS

The obtained analysis results of the old two-wheeled model of the Segway and new four-wheeled model of Segway are compared. The stress on the base of two-wheeled models of Segway is noted to be 6.035×10^{-5} N/mm^2 and the total deformation on the base of the four-wheeled model of Segway is noted to be 3.5564×10^{-6} N/mm^2. From these values, the four-wheeled model of Segway shows better results than a two-wheeled model of Segway.

IV. CONCLUSION

The design and fabrication of motorized personal transporter are aimed at providing a zero pollution environment to a considerable distance at a lower cost. To overcome toppling caster wheels are attached to the base thereby increasing stability. The personal transport vehicle can build a hybrid. In the future, attach the solar panels or using any other means of renewable sources for proving energy to the personal transport vehicle. Hybrid technology will play an active role in personal electric vehicles in the future.

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