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RESEARCH ARTICLE

FABRICATION AND TESTING OF BIONIC BOOT

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ABSTRACT

As in today's world and in future, there is only requirement of the people that everyone want to a fast, efficient and precise work output with the use of less human effort. Hence, thinking upon the requirement of people, we as a student of mechanical engineering are going to give the idea of "BIONIC BOOT" which turns a man towards superman. It will increase the human capabilities. We got inspired from the kangaroo which can run to maximum speed of 44 mph due to its special type of back feet structure. They can store the elastic energy in their back feet and release of this elastic energy generates 80% more power than in humans. Hence we decided to make the same replica for the human beings which will store and release the elastic energy similar as "kangaroo." The bionic boot could increase the speed of humans to 25 mph. It will also help in running off road or climbing hills. As we know that there are limited amount of fossil fuels present in the world. But in India, approximately 60 to 70% people use the two wheelers for the small distance transportation. Hence to reduce the dependency on fossil fuels for the transportation of people we have given the idea of bionic boot. The bionic boot makes the human beings more active. To make a pair of bionic boot we have used iron strip, high strength spring which can store and release the elastic energy, nuts and bolts, GI sheet, rubber and wooden blocks. Generally, the purpose of bionic boot is to increase the running speed of human beings.

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INTRODUCTION

As we know that there are many animals present in the world that can run faster than a man. In between them, there is an animal named as Kangaroo that can also run faster than a man because of their back feet structure. Due to special type structure of their back feet of kangaroos they have the energy storing capacity that helps them to jump or run faster. There are many components available in the mechanical engineering field that can store and release the energy such as spring, rubber, hydraulic and pneumatic system, highly elastic wires etc. Here, at the initial level, we have used the tension spring for the formation of bionic boot to fulfill the requirement of the human being to run fast with the use of less human effort. With the bionic boot the running speed of human can be increased approximately up to 25 mph. It can be used for small distance transportation very easily. And it may be the best alternative for the two wheelers. The bionic boot let you run as fast as a slow moving car.

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Problem Statement- To fabricate the attachment for improving the abilities of the human for faster running, climbing and jumping with the less human effort so as to facilitate longer and safer travel.

Objectives

- To improve the human capability for greater performance.
- To reduce the dependency on fossil fuels and promote the physical exercise of human.
- To add a new mode of transportation

Scope- There is a scope for futuristic transportations, hill climbing & sports era

Methodology

Step 1- Basic design
Step 2- Material selection
Step 3- Virtual Analysis
Step 4- Fabrication/Manufacturing
Step 5- Testing
Step 6- Conclusion

Material Survey

- Strong iron strips.
- Tension Spring (spring rate may be taken as 1.3 to 1.6 of body weight).

Fig.1. Tension Spring

- Rubber bumper or feet (1/3 of the body size).
- Rubber base.
- GI sheet for making the shape of feet.
- Foam matting (approximately 3cm thick).

We can also use the fiber reinforced plastic and aircraft grade aluminum in place of iron to reduce the weight of the bionic boot. Mild steel or plain carbon steel may be used because of their low cost availability.

Cad Drafting

Fiber Reinforcement Plastic Moulds

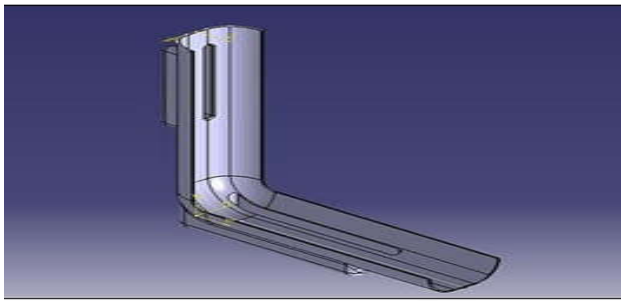

Fig.2. FRP Mould

Strut Member

Fig.3. Strut Member

Bushing

Fig.4. Bushing

Spring Mounting

Fig.5. Spring Mounting

Tyre Rubber Base

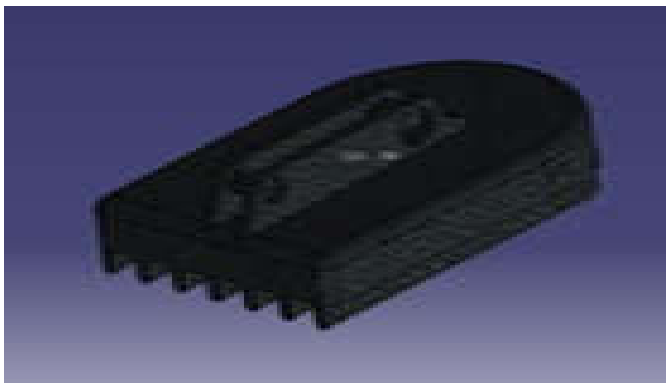

Fig.6. Tyre Rubber Base

Final Assembly

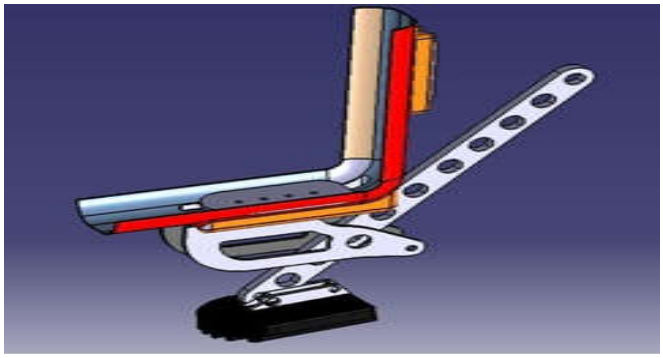

Fig.7. a Final Assembly

Exploded View

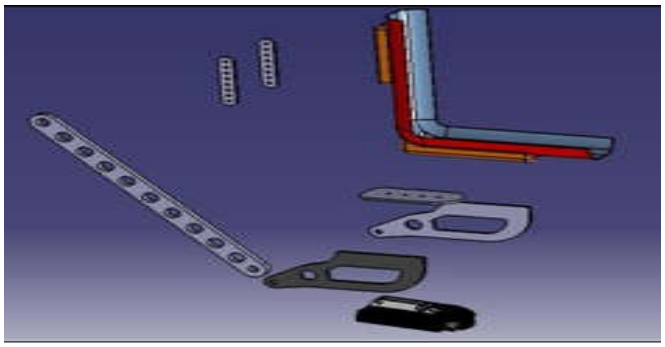

Fig.7.b Final Assembly

Load Estimation and Analysis

Strut Member

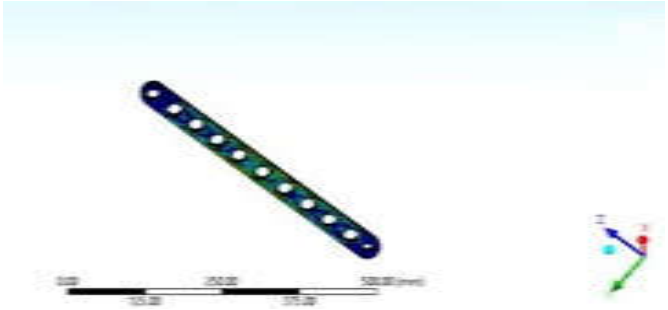

Fig.8. Stress Analysis of Strut

Pivoting Assembly Plate

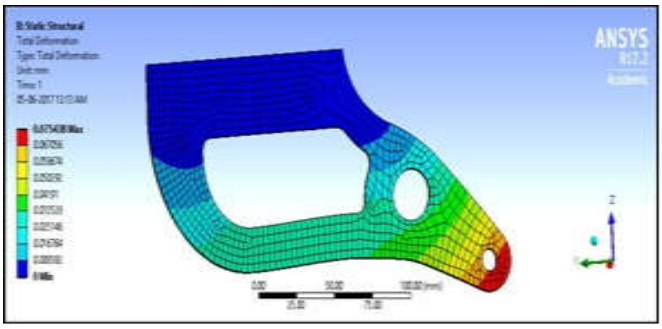

Fig.9. Total Deformation in Pivot Plate

Manufacturing and Construction of Bionic Boot

Joinery Tools

- A lot of nuts and bolts. (4 or 5 mm work well)
- A drilling machine and appropriate metal drill bits (mostly 4 or 5mm for the bolts)
- A pair of old willies in your shoe size (optional but fun)
- Flexible tape measure (for clothes works best)
- Hacksaw or metal cutting saw.

Measuring the Component for the Construction of Leg Brace

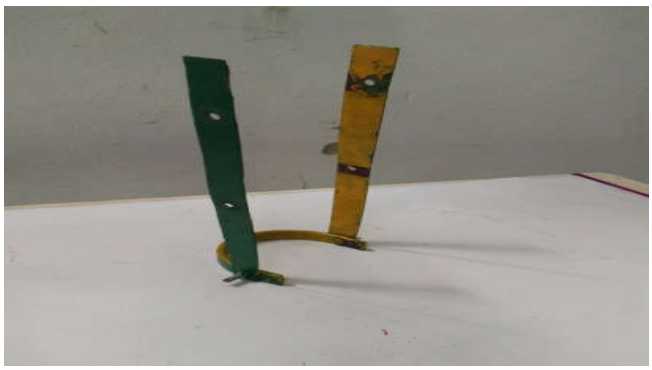

Fig.10.a Leg Brace

- Starting from top down measurement, measure the circumference just below the knee of your leg. Cut it from the iron strip and bend it approximately to a circular shape with the help of vice and hammer leaving 5cm distance between two ends to allow the feet to slip comfortably.
- Now take the measurement from 1 to 4 i.e. just above the ankle as shown in fig.10. It needs 2 pieces per boot. Cut it from the strip. No need to bend it.
- Part 3 is just half of 1 and bent to semi circular shape.(in fig.10)
- Now measure the portion just above the ankle and bend it to U shape. This will become clear while assembly.

Assembly of the leg brace

Fig.10.b Final Leg Brace

All the components are cut and ready for assembly. Now make drill holes with the help of drilling machine and drill bit in all the components. First make 3 holes in part2, one at the top, another at the bottom and third one at a distance of 2/3 of the part2 from the part4 (described in fig.10). Now make the 3 holes in part3 and 4, one at the middle and another two at the two ends respectively. Now make two holes in the part1 at the two ends. Now assemble the all the components with the nuts and bolts to make whole assembly of the leg brace.Ensure that it fits comfortably on your leg, if there is some rubbing or tightness on your ankle. This is common and will be sorted when attaching the rest of the boot.

Construction of feet

Fig.11. Feet

Now the brace is completed and just put it at one side. Now take the GI sheet and trace the shape of the foot and mark about 2.5cm in border of the foot. Then, using a GI sheet cutter cut out around this outer line to create a panel for your foot. Then, using the appropriate hammer, smack it to make a border to stop your foot slipping off, using the line shape around your foot as a reference. Now it's time to take a pair of scissors to remove the sole of the old shoe. Then attach the willies at the bottom of the metal shoe with the help of strong glue. Now at

the last in this step, add the accessories and connectors for the mechanism (i.e. leg brace assembly) to be set on it. Now make a U shape (8*9*8) after cutting off 25cm piece from the iron strip, then take the shoe and drill 2 holes through the center of the heel about 1.5cm apart to each other. Also cut a 25cm long straight iron strip (measurement with welded part) to support the bottom base of the shoe and drill 2 holes same in the shoe. Now attach the U shaped iron strip to the shoe with the help of nut and bolt.

Attachment of the leg brace to the foot (ankle attachment)-

Now this is the time to attach the leg brace to the foot i.e. attachment at the ankle. While testing with the shoe we found that it is risky and uncomfortable at the ankle site and it may be harmful for the bone and the muscles at the ankle. Hence we decided to make a reverse L shape by bending the 30cm iron strip at 90 degree from the hole in the shoe after the U shape attachment to the end of the shoe. Now make 3 drills in it, one with the shoe attachment, second one with the part4 (above the ankle) and third one with the part3 as shown in fig.11. Now join the perpendicular shape with the shoe, part 4 and part2 (shown in Fig.11).

Attachment of the spring in the Mechanism

Fig.12.a Bionic Boot

We have attached 2 springs in the mechanism for one shoe; one at the top below the part3 and another at the bottom with the rubber block as shown in fig.12. For making this arrangement we have joined the 20cm strip with a handmade shape (25 cm overall) by welding as shown in fig.12. Then make two concurrent drills (about 8mm) at the knife edge tip of the handmade shape and cut a 40cm straight iron strut; then make drills of about 8mm on 40cm long strut(taking distance between the drills of about 1.5cm). Now make this long strut hinge with the help of bolts and nuts such that the inclination angle is 45degree approx and attach the springs to the strut.

Strapping and foot Padding

Now take the straps from the old schoolbags and fasten it to the leg brace just below the top ring, at the middle ring and at the ankle. Also fasten the straps on the shoe at the suitable place for holding the foot and leg. Now we have used approx 3cm thick foam for the comfort ability of the human and to prevent the leg from the bolts facing it and stick it at the above portion of the shoe.

Fig.12.b Bionic Boot

Working and Mechanism

As we know that Newton's third law of motion states that "Every action has equal and opposite reaction." Hence taking this law into consideration, if a man runs with the normal shoe on the hard and rough (i.e. rigid) road, he will act upon the road by pressing it and the road will also react with the same force in opposite direction. But due to the rigidness of the road most of the energies are lost. And in the 2nd phase if a man runs with the BIONIC BOOT on the rigid road, the effort of the man is given to the road as well as spring also. As usual the rigid road will react as discussed above but the spring has the property that it can store the energy and then release the energy to regain its original shape. Hence the energy given by the human is firstly stored in the spring as a potential energy and then to regain its original position it releases the energy as a kinetic energy which results in the generation of sudden thrust that helps a man to run faster with bionic boot than with the normal shoe.

As in the mechanism we have made a iron strip, hinged through some point such as it make an angle of 45 degree to the bottom surface and also connected with the springs at the top and bottom of the strip with the brace and rubber bumper. When a man presses the rigid road with the bionic boot, the road reacts and both the springs get stretched after that they recover its original position by relieving the pressure that will snap back forcing the lever to its original position, propelling boot and man with more energy than a standard muscle could manage run faster. The spring rate may be taken as 1.3 to 1.6 of human body weight.

Advantage

- Running speed is increased up to 25 mph compared to normal shoe.
- Mechanical advantage is increased.
- It can be used on the rigid road as well as hilly areas.
- It can be the best alternative of the fossil fuels for small distance transportation of human.

Since, Mechanical advantage = Output /Human Effort

Here the human effort is same as in the normal shoe but the output (i.e. running speed) is increased, hence the mechanical advantage is increased.

Application

It may be used by the teenager and older people on the road and hilly areas also.

Precaution

It should be tested safely with 4 to 5 people at safer place because it needs a lot of practice.

Conclusion

To use the BIONIC BOOT as new booties, aesthetics is necessary. No more things but we can use the paint (not on moving part) for the aesthetics. Now the boot is ready to use.

1. To enhance the human capability for greater reach and improved performance.
2. To introduce a new mode of transportation between destinations.
3. To take a step in new direction of bio- mechanical engineering to facilitate completion of bio-suits for future adventures.

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