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DESIGN AND FABRICATION OF WEARABLE CHAIR

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ABSTRACT

We have designed and fabricated wearable chair for reducing the pain of long standing. It is a mechanical ergonomics device that is designed as per the shape and function of the human body, with segments and joints corresponding to those of the person it is externally coupled with it. The device never touches the ground, which makes it easier to wear: a belt secures it to the hips and it has straps that wrap around the thighs. These are specially designed for industrial purpose on assembly line or continue standing works like manual welding. It is attached with any footwear and touches the ground only when in a stationary position. The user just moves into the desired pose. Pneumatic cylinders are used in this project so that all the load is taken by the cylinder and is transferred to the ground through wearable.

Keywords: – Ergonomics, Exoskeleton, Wearable, etc.

1. INTRODUCTION

If you work in an industry then you'll know how tiring it can be to stand for several hours at a time. Unfortunately, however, it isn't always practical or safe to carry a stool around with you wherever you go. That's why we created the wearable chair. Worn as an exoskeleton on the back of the legs, it lets you walk or even run as needed, but can be locked into a supporting structure when you go into a sitting position. Now in prototype form and being actively marketed, the device utilizes a powered variable pneumatic double acting cylinder to support and suspension the wearer's body weight. The user simply bends their knees to get down to the level at which they'd like to sit, and then engages the bolt into required slot. The Wearable Chair then locks into that configuration, directing their weight down to the heels their shoe, to which it is attached it also attaches to the thighs via straps and to the waist using a belt.

2. LITERATURE SURVEY

S. T. Mccaw and b. T. Gates described the effects of mild leg length inequality on posture has been the source of much controversy. Many opinions have been expressed both for and against the need for intervention to reduce the magnitude of the discrepancy. Their paper emphasizes the need for accurate and reliable assessment of leg length differences using a clinically functional radiographic technique, and reviews the biomechanical implications of leg length inequality as related to the development of stress fractures, low back pain and osteoarthritis. **[1]**

Aydin Tozeren wrote a book on how Human movement obeys basic laws that govern static and dynamic bodies, and this textbook takes a quantitative approach to studying human biomechanics. A quantitative approach to studying human biomechanics, presenting principles of classical mechanics using case studies involving human movement. Vector algebra and vector differentiation are used to describe the motion of objects and 3D motion mechanics are treated indepth. Diagram and software-created sequences are used to illustrate human movement. **[2]**

Robert Peter Matthew et.al. work helped us get an overview on active and passive type of exoskeletons. Assistive devices such as exoskeletons are capable of providing rehabilitative improvement and independence for individuals suffering from musculoskeletal conditions. Typical devices use either active assistance methods such as DC motors or passive methods such as springs or orifice valves or levers. **[3]**

3. OBJECTIVE

1) Design of wearable chair using two pneumatic double acting cylinder using Solid works.
2) Fabrication of wearable chair using M.S. and the elastic strips for support with 3D printed shoe holders.

4. METHODOLOGY

Analysis

As we visited in the market & online sites of exoskeleton we saw a Wearable chair using a carbon fiber reinforcement plastics material and their cost, load lifting capacity etc. and we got result. This analysis would helped us a lot to design the model as per the organization requirements. After the market analysis we developed a virtual design by using Solid work software

Design & development.

Applied different fabrication process (drilling, Turning, Laser cutting, Bending, 3d printing) on MS Metal sheet to develop the exoskeletion . Finally physically tested as we got result of its working & load Carrying Capacity

5. MODELING AND ANALYSIS

The design of the mechanical assembly is derived from the scaled dimension the Wearable Chair. The material selected to prepare the prototype model is Mild Steel due to its properties like hardness as it can be strong and drilled fabricated easily into any shape.

For the mechanical point of view, we had used a Pneumatic Double Acting Cylinder and helical compression spring for suspension point of view .and 5/3 Pneumatic valve for holding a the 3 position: Standing ,Seating and Neutral.

1. Design of bolt
2. Design of spring

1. Design of bolt -

DIAMETER OF BOLT TAKEN = 7.6 MM

THE BOLT IS SUBJECTED TO SHEAR FAILURE LOAD APPLIED BY SINGLE PERSON = 100 KG= 100 X 9.81 = 981 N

FORCE ON SINGLE CYLINDER = 981/2 =490.5 N

AREA OF BOLT = 3.14 / 4X(DX 0.84)2

AREA OF BOLT =3.14 / 4 X (7.6X 0.84)2

A= 51.91 MM2.

2. Design of Spring –

MAXIMUM WORKING LOAD = (FMAX)=300 N

MINIMUM WORKING LOAD = (FMIN)=100 N

LENGTH OF SPRING AT MIN. LOAD=200 MM

LENGTH OF SPRING AT MAX. LOAD=60 MM

AVAILABLE WIRE DIAMETER (D) = 1.5 MM

MEAN DIAMETER (D)=5 MM

Shear stress = 8FCK/πd^2

Calculate Spring index by using following equation:

C = D/d = 5/1.5=3.33 mm

Calculate curvature Factor K = (4C-1/4C-4)+(0.615/C)=(4×3.3-1/4×3.3-4)+(0.615/3.3) =1.51

Shear stress =(8×300×3.33×1.51) /π×1.5^2 =1662.6 N/m^2

Table 1: Components used in the Wearable chair

Sr .no	Description	Material	Qty
1	Pneumatic Cylinder	Std	2
2	Height Adjusting Pipe	MS	2
3	5/3 Position control valve	std	1
4	Shoe holder	ABS plastic	2
5	Extended support	ABS plastic	2
6	Seat	Nylon	2
7	Leg Supporting Arm	MS	2
8	Helical Spring	SS	2
9	Union T	Std	2
10	M8 Bolt	Std	2
11	M8 Nut	Std	2

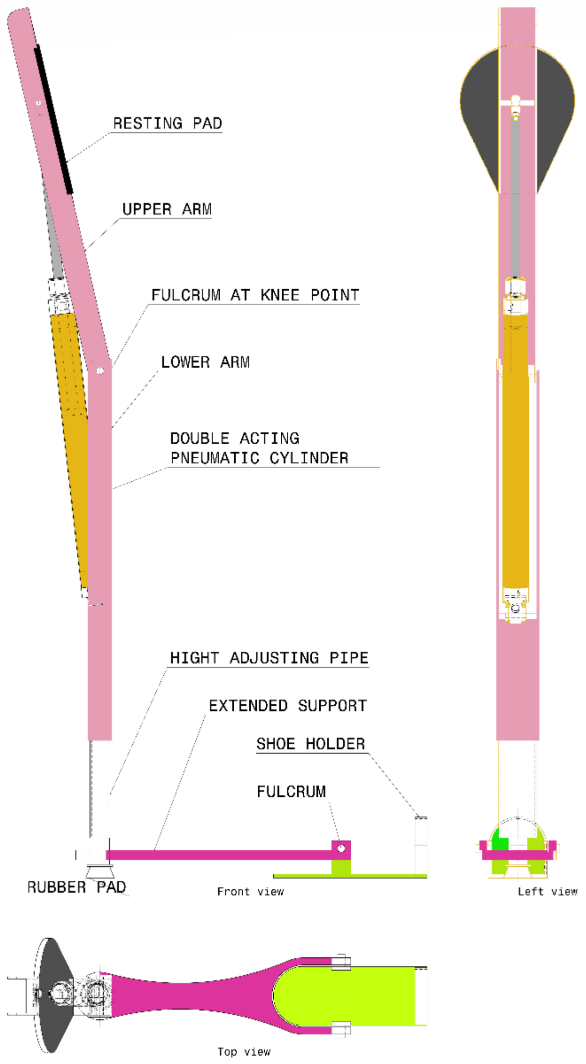

Fig no .1 – Solid work drawing

6.CONSTRUCTION AND WORKING

1.DOUBLE ACTING CYLINDER

Fig no 6.5 Double Acting Cylinder

We will buy a Double acting cylinder for which will make a suspension system the cylinder isfixed between upper arm and lower arm with help of nut and bolt arrangement .Both end of the piston cylinder is tightened with the help of nut .The cylinder has 25 mm bore and 200 mmstroke length provided with the one position control valve.

2.Height Adusting Pipe –

Fig no 6.2. Height Adusting Pipe

For adjusting a height or sitting posture we use of this pipe .in height adjusting pipe one shaft is their the total height of shaft is 160 mm ,inner diameter is 25mm and outer diameteris 30 mm. we use MS material for shaft and pipe.

3. Leg Supporting Arm -

Fig no 6.3 -Leg Supporting Arm

In this assembly we MS mateial cut C-frame by using laser cutting thickness is 2mm andafter cutting bend at 90 degree.Its provide support to leg.

4.Assembly Of Shoe holder with extended support -

Fig no 6.4 Height Adusting Pipe

For extended support and shoe holder we use a 3d printing method and use a ABS (Acrylonitrilebutadiene styrene)is Common thermoplastic polymer.it will help for adjusting our sitting position .according person sitting posture.

6.5 - 5/3 position control valve -

Fig no -6.5 -Position Control Valve

We use a 5/3 position control valve for controlling the position of 3 steps Seating ,Neutral, Standingwhen we push a lever up then piston cylinder is goes up and when lever at middle position this is neutral position and lever push down side cylinder goes down .

6.6 Working OF Wearable Chair –

Before Seating on the chair Adjust height of Chair there is 4 slot available for adjusting the height Adjusting pipe and Wear a Support belt around your thighs then seat on chair and According your shoe size adjust a strip around your shoe the strip attach with shoe holder. When we seat on chair piston cylinder is goes down at top dead center and air is entered into the cylinder after getting a desired or required position lever of position control valve push at center or neutral position so that air is trap or block into cylinder and hold at desired posture. We round a Helical compression Spring around piston of cylinder it will helpful for suspension. We connect pneumatic pipes both end of cylinder and position control valve with the help of Union “T”.

At the time of standing push lever of position control valve at upper side after that piston is goes towards the top dead center and spring is retracted so seat of chair is goes on upside then again push a lever at neutral position for holding current position of chair. In this Chair we Provide a extended support for seating in comfort posture it is connected at the end of height adjusting pipe.

6.6 Complete Assembly Line -

Fig no 6.6 Complete Assembly

7. RESULTS AND DISCUSSION

The advantages of this project is to increase safety of operator by using the exoskeleton . This can increase the efficiency of the operator to standing long time. During the testing we analyzed the thing was the weight of system is little but heavy for walking of operator one station to another station because of we use a MS material for Assembly of leg supporting arm .This is our first prototype model next time we will change in our design and use Carbon Fiber Reinforcement Material (CFRP) so they can help to reduce our Assembly weight and provide a strength as compared to MS.

8. CONCLUSION

1) Design of wearable chair was done using Solid work software with pneumatic Cylinders
2) Fabrication of wearable chair was done which can lift weight up to 300 kg using two pneumatic cylinders which load is transferred to the ground using 3D printed shoe holders.

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