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DESIGN AND MFG. OF CHAIRLESS CHAIR

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Abstract: It is very difficult to stand and work for overall shift in the company by a worker. This will reduce the efficiency of the worker. The solution to this problem is to have a portable device, which has an ergonomic design, low cost exoskeletons. In this work a mechanical ergonomics device that is designed around the shape and function of the human body, with segments and joints corresponding to those of the person it is externally coupled with. It functions as a chair whenever it is needed and is coined as Chair less Chair. Worker in industrial can wear it on legs like an exoskeleton. It locks into place and you can sit down on 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 and part of the mechanism, but an alternate version works with any footwear and touches the ground only when in a stationary position. The user just moves into the desired pose. It will fit closely to lower part of the body as an external body part on which maximum body forces act upon. It is a cost effective product and any error in design may fail the structure, which creates loss. So, these forces should be carefully analyzed during the design of structure. The best way to predict these forces during pre-manufacturing stage is to make an analysis on the structure with the help of software. This helps in estimating the stresses induced on the structure, which is one of the most important criteria for evaluation of the model.

Keywords: The Exoskeleton; chair less chair; ergonomics.

I. INTRODUCTION

Exoskeletons are defined as standalone anthropomorphic active mechanical devices that are “worn” by an operator and work in concert with the operator’s movements. Exoskeletons are mainly used to increase performance of able-bodied wearer. (e.g. for military applications), and to help disabled people to retrieve some motion abilities. (such exoskeletons are called “active orthoses” in the medical field). As we know, the normal motor capability of legs is crucial and important for human-being’s daily life. Legs, however, are apt to be injured in accident. And the Rehabilitation is essential for the patients to recover after leg operation. Additionally, diseases, stoke for instance, can also result in the loss of leg function. In order to regain the motor capability, the leg rehabilitation is a fundamental therapeutic approach. Basically Exoskeletons are of two types:

1.Active Exoskeletons
2.Passive Exoskeletons

Active exoskeletons: They are powered by external sources like a motor, battery powered etc. They work along with the passive exoskeletons to help in its functioning.

Passive exoskeletons: These are not powered by external power sources but work on the basis of mechanical linkages, pneumatic and hydraulic mechanisms, spring controlled devices etc. Since active exoskeletons pose a restriction to the amount of external energy that can be supplied in terms of quantity, quality and time we have focused purely on passive type of exoskeletons. Passive elements are implemented in the exoskeleton to either store or dissipate energy with the objective of reducing the residual energy that the human would have to expend for locomotion. This device, we call as chairless chair possess minimum weight as compared to a normal chair and is mobile and portable. A virtual chair, which can be imagined as an exoskeleton can be worn on a person’s lower body part. With the help of this he/she can move anywhere and sit anywhere and anytime he/she wishes to. The use of chairless Chair is likely to bring down the cases of MSD (Musculoskeletal Disorders) which develops in workers indulged in prolonged standing conditions. By using this device, you can walk or even run as needed, but can be locked into a supporting structure when you go into a sitting position at different angles.

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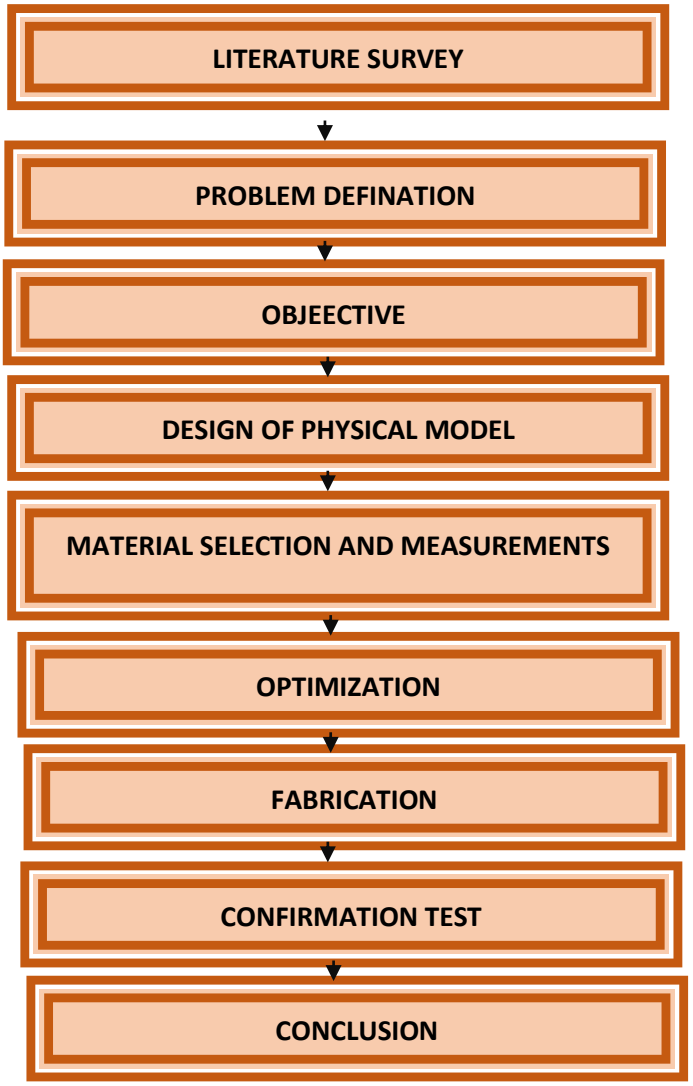
II. RELATED WORK

Workers in workshops and industries need to undergo several sitting and standing postures for long hours depending on their work load. We came across a worker in a local manufacturing industry. He mentioned that he suffers from severe muscle pain every day after his work. So, as a remedy to reduce muscle stress and to work freely, providing a support below the hip was a solution. Finally, we heard about an exoskeleton support that can be provided to the body as a support while doing work. Several Journals were published related to this topic earlier. Noonee, a swiss start-up introduced the chairless chair for BMW and Audi in the year 2015. It's working was controlled by mechatronics system. H. Zurina and A. Fatinhas worked on the Design and Development of Lower Body Exoskeleton. Aditya Bhalerao and Sandesh Kamblehave worked on the Pneu portable chair for employees to seat while working. Apart from that our chairless chair is based on simple link mechanism and does not require any battery or power for successful working and is manually controlled. So this make it acceptable and affordable for every common people.

This was created by Zurich-based startup noonee, this Chairless Chair helps users to rest their leg muscles by directing their body weight towards a variable damper attached to the battery powered device. This chair is worn like an exoskeleton, allowing users to walk with the device while they are working. To use it, simply bend the knees to a comfortable stance to activate its damper that supports your body weight. Keith Gunura, the CEO and co-counder of noonee, told CNN that the Chairless Chair helps users maintain a good posture. "This helps to keep the back straight and can reduce the occurrence of bad postures for both healthy workers and those recovering trom muscle related injuries," said Gunura.LetsTake a look at the Chairless Chair below, which will be used in a trial in Germany, starting with BMW in September, and with Audi later this year.

III. METHODOLOGY



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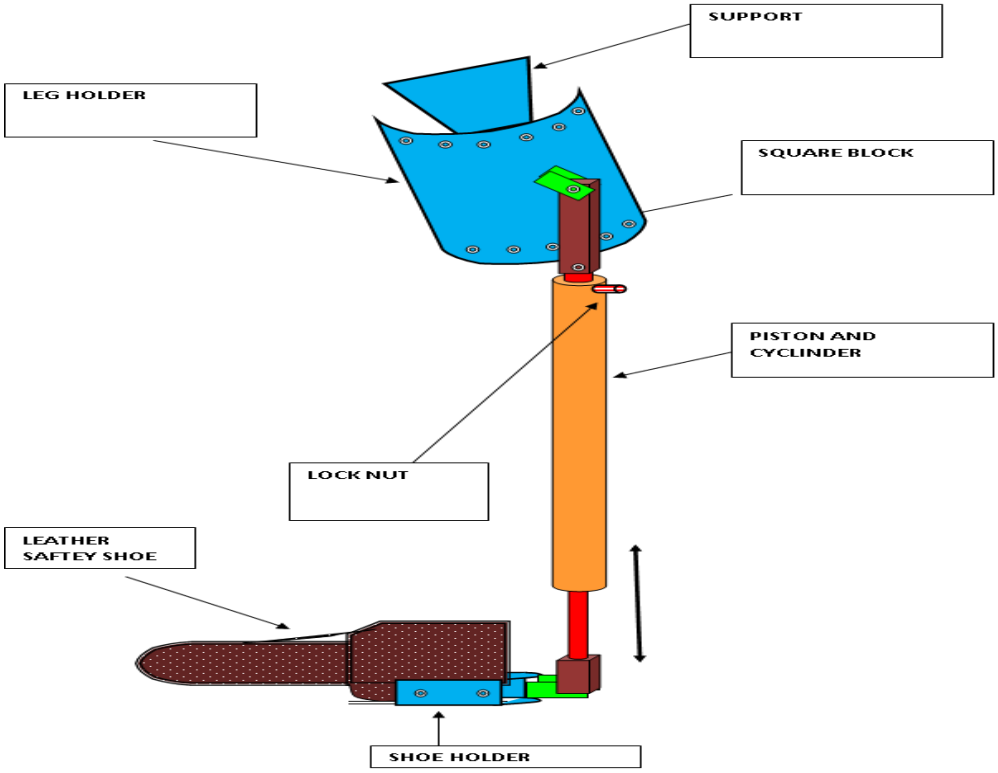
To support human lower body part which is an exoskeleton especially worker need to stand more than 5 hours per day, methodology of this work is concentrated on the need to developed the simple chair. When a worker wants to seat, pushing a button, by which at the desired angle the frame locks. Through the frame to the floor or the heels, the weight of the body is transferred. To hold the limbs tightly a rubber band will be used, in order to fix the position to the exoskeleton. This product worn on the legs, which allows the user to walk or run when no activated. When the device is activated it uses a variable damper to engage and hold person's body weight, relieving the stress on leg muscles and joints. The wearer just need to move into the desired pose, this activates the device.

Working System:

We have to design following main component: -

- Damper: The function of damper to carry the load of worker. We have designed it for 100 kg load.
- Sheet: Mild-sheet sheet required to give support to the worker and to fascinate the sitting position.
- Tie belt: Belt is used for strapping of exoskeleton to human body. Belt will be taken as standard material available in market to wrap the model as waist and thighs.
- Safety shoes: Shoes are the last of model, which is attached at bottom place and to be wear at the time of working. Shoes are selected as standard size of number.



Cad drawing

- The entire model has been designed with the help of designing software solid works.
- With the help of colour feature the colours are given to the entire model.

CALCULATION OF PISTON CYLINDER

We have ultimate stress for cylinder material $\sigma_{ultimate}$ = 300 N/mm^2 aluminium alloy

Considering factor of safety as 4.

We get permissible stress = ultimate stress/factor of safety

$\therefore$ $\sigma_{tensile}$ =300/4

$\sigma_{tensile}$ = 75 N/mm^2

Inputting these value in thickness formula,

We get, t = 3.12 x 20/2 x 75

= 62.4/150= 0.416 mm.

t = 0.5 mm

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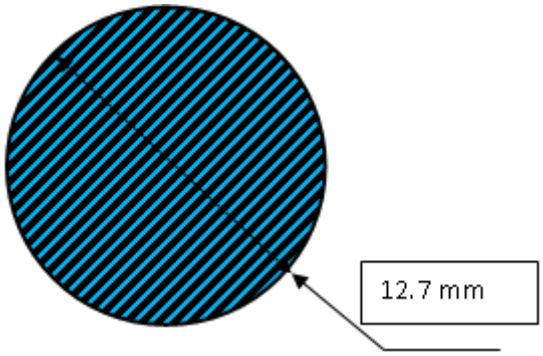
but standard available cylinder in the market is 3 mm thick, so our design is safe.
Outer Dia. of cylinder = 20 + (2 x 3) = 26 mm
The minimum outside dia of cylinder is 26 mm

CALCULATION OF PISTON ROD:



Load of person on piston rod, so it may fail under bending.

$M = WL/4 = 981 \times 250/4$

$= 61312.5$ N-mm

$Z = \pi/32 \times d^3$

$Z = \pi/32 \times 12.7^3$

$Z = 201\ mm^3$

σ_b (induced)$= M/Z = 61312.5/201 = 304.8\ N/mm^2$

As induced bending stress is less then allowable bending stress i.e. 655 N/mm^2 design is safe.

CALCULATION OF BOLT

Bolt is to be fastened tightly also it will take load due to rotation. Stress for C-45 steel ft =420 N /mm^2. Std nominal diameter of bolt is 9.31 mm. From table in design data book, diameter corresponding to M10 bolt is 8 mm.
Also, initial tension in the bolt when belt is fully tightened.
P = 981 N is the value of force

$P = (\Pi/4) x\ dc^2 x\ ft$

$\sigma = (Px4)/(\Pi \times dc^2)$

$\sigma = (981x4)/(\Pi \times 8^2)$

$\sigma = 19.51\ N / mm^2$

the calculated ft is less than the maximum ft hence our design is safe.

MANUFACTURED PARTS

Shoe with shoe holder

Upper support

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Thai holder

Pneumatics cylinder

IV. CONCLUSION & FUTURE SCOPE

Conclusion:

In this project design and fabrication of Chairless chair has been done. The main goal of our project was to give the comfort to workers, who work on production line for hours. Also, to make the model at least cost, that has been achieved. The work started with designing of model and procurement of required material. Finally, fabricated Chairless Chair at workshop. The model is working satisfactorily. This concept was new and the data available was also limited. There is some future modification possible.

The Chair-less Chair Exoskeleton system is successfully designed and analysed. The aim of this project is to develop a lower body external skeletal structure to support sitting and partial standing posture. The finite element analysis is performed on the chair-less chair, using Solid works Simulation add-on to find total deformation. Maximum displacement, maximum stresses and deformations are analysed and safe load is determined. Future work will focus on making the design lighter and using high grade materials for greater strength at smaller dimensions and weight. Implementation of the design and testing in real world environment is to be done and effectiveness in daily scenarios is to be determined.

Future Scope:

The basic operation of this machine to reduce fatigue by sustaining the weight of the wearer in a similar fashion as that by a regular chair as your leg weakness progresses due to increasing in your age, your health care team may recommend equipment known as ambulation aids and bracing to help you with walking. Other devices can help give you needed support as the muscles in your neck and arms weaken. There may be a use of such exoskeletons which can give more effect than braces and ambulation aids. The specific aid or device that's best for you depends on the extent of the weakness and your willingness to use such a device. Using such instruments for walking climbing, doing work is safe and you're confident that you won't fall. For some, this means having an attendant or using an assistive device when walking short distances. Such instruments are going to bring more flexibility, mobility and most importantly the confidence Apart from in medical therapy and military sector, active or hoses or exoskeletons offer other applications, for example as a power booster during assembly work in production. They act here as a strength support device to prevent signs of fatigue that occur especially when performing repetitive actions.

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