Design and Analysis of Wearable Chair By Using ANSYS

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ABSTRACT: -

We have read the medical news about exoskeletons developed to empower people to walk and leap but there is another pathway for the application of exoskeletons, this time being a wearable device that can help working people in settings such as factories experience better comfort. Some workers have tasks that make it difficult for them to avoid the stress and fatigue of having to stand, bend, and stoop for long periods, assuming postures that may cause physical, muscle-related problems.

The creators say the Chair solution is here, and they are referring to their product, the Wearable Chair. In this instance, researchers are promoting a wearable device that can help people at work maintain optimal posture. This is a wearable chair that could be worn by production-line workers and old age people the wearable chair idea is to relieve the stress of tasks that can cause such problems and pain. Unhealthy postures also lead to fatigue. Whether the difficulty is pain or fatigue or both, the worker's issue becomes a productivity issue, which is not beneficial to employers. The product as a wearable ergonomic leg device; or a leg exoskeleton; or a powered, lightweight and energy-efficient lower limb posture-support device.

Millions of workers have to stand all day, which strains the back and the lowerlimbs. By creating a new sitting device, one can improve comfort and reduce theforces acting on the knee. Observation of the human knee shows that there is no single center of rotation as there is in a hinge joint. Rotation occurs together with translation. Therefore, ajoint is needed which follows the natural trajectory of the knee. Four-bar linkages follow a predetermined trajectory and or a great rigidity butare not able to cope with differences between users. Therefore, three adjustablejoints are constructed and compared to each other.

Keywords:- Assembly Line, exoskeleton Disorder (MSD), Flexible Wearable Chair, Comfort, lower limb posture-support device.

1.INTRODUCTION

Standing all day long on the feet tires the muscles of the body. Over a long period of time, pain and musculoskeletal disorders will rise. Today, millions of workers suffer from the problem that they cannot place a chair at their workplace. This situation can be changed by developing an assistive device for sitting. Withoutthe use of a chair, it will be possible to sit anywhere in any position.

Wearable chairs have a history of 37 years in 1977 Darcy Robert Bonnet invented a wearable chair which allowed users to sit on two legs, which was not obvious. But the design suggested by them has some demerits Viz. it allows only one sitting position, irrespective to the user desire, also there is large stress on lower Leg resulting from the reaction force imposed by the lower bar. The basic idea is that introducing internal hinges To the mechanism (structure when sitting) releases joint moment and providing these hinges coherent with human lower body joints helps in releasing severe joint stresses which occur during working. But the approach Poses some ergonomic challenges, the biggest problem with such a design is ensuring that workers can move Freely and after sitting, it is in stable equilibrium. It is well illustrated that how flexible wearable chair satisfies Static equilibrium and stable configuration under loading. The study conducted by Anita *et al.*

On a Random sample of 255 workers of the median age of 24 years show that older age group is more susceptible to MSD (Muscular Skeletal Disorder) than younger age groups.

The prevalence of MSD among the automotive assembly line workers was 78.2% and now it is necessary to identify the body part/segment which undergoes severe stress cycle so that proper Treatment has to be given during the incubation period of the muscular disorder.

Fig:- The chairless chair of Noonee

2.LITERATURE REVIEW

In this paper we are very much interested in the wearable devices which help in increasing the efficiency of the human and decrease the rate of fatigue of human during work. The device discussed here is the passive device. This device is also known as Chairless Chair which helps the wearer to work effectively at any location in a sitting posture.

[1]ASHUTOSH BIJALWAN AND ANADI MISRA worked on Design and Structural Analysis of Flexible Wearable Chair Using Finite Element Method. The objective of this paper is to focus on the mechanical design and finite element analysis (FEA) of the mechanism using ANSYS software. In the present work all the parts of the mechanism are designed under static load condition. The results of the analysis indicate that flexible wearable chair satisfies equilibrium and stability criterion and is capable of reducing fatigue during working in an assembly line/factory. This paper mainly focused on to design and analyze a chair which can be adjusted as per work's gesture and posture minimize the load acting on the body parts and when needed it can be portable from one place to another place. MSD is burning issue which is faced by ergonomist in the present scenario and has to be relieved. Further one can observe that implementing flexible wearable chair technology leads to easing muscle fatigue (MSD) and an increase in the productivity which makes it an integral part of workstations design.

[2]PAWAR AKSHAY ,PATIL KSHITIJ, NIKAM PRAFULL, PAGAR GANESH AND GUJRATHI T V worked on Design of wearable chair. The primary goal of the venture is to lessen weariness because of consistent standing stance amid working hours and increment working proficiency of client, and henceforth venture has some more destinations. To give legitimate working condition without interfering with work process. Decrease weight of seat. Decrease cost and multifaceted nature of system& make framework as straightforward as conceivable to utilize. Henceforth our plan is reasonable and uncommonly intended for the general population at various sequential construction system work Due to this course of action people groups felt loose who were experiencing the back agony and spinal string ailments. The plan venture is a win in view of tilting gadget. It decreased body weariness and expanded the workability of the individual in the available time and in addition in the business places.

[3] PROF. AMIT BHAGAT, SHUBHAM V. TAWARE, TUSHAR V. SUTAR, SANKET R. SHELKE AND ROHIT K. SURYAWANSHI worked on Design and manufacturing of wearable pneumatic chair. The objective of that project is so simple with the help of chairless chair worker can move freely here and there without any stresses and fatigue or pain. Pneumatic cylinders are used for smooth suspension which makes comfort to a worker. It improves walking and running economy and reduces the joint in pain or increases the strength in joint. It transfer load directly to ground. The exoskeleton is powerful mechanical devices. In pneumatic support, a pneumatic cylinder is used to engage and hold the person body it only wraps around thighs so it reduces fatigue and increases the productivity. Hence our design is affordable and specially designed for the people at different assembly line work Due to this arrangement peoples felt relaxed who were suffering from the back pain and spinal cord diseases.

3. METHODLOGY

a) Clarification of the task. This stage includes collecting information or data about the conditions that will be fulfilled by the design of the tool and also its limitations. The results of this stage are terms or specifications.
b) Conceptual design. This stage includes information on the structure of the search function the principles of problem solving that are suitable and combine into a variant concept the results of this stage are basic problem solving or concepts.
c) Embodiment design. This stage includes a sketch of a combination of principle solutions that have been made in the form of an initial layout. The principal solutions that meet the requirements that are in accordance with the specifications and are good according to technical and economic criteria are selected. The initial layout that is chosen and developed
d) Into a definitive layout is a form of design that suits user's needs and expectations. The definitive layout includes several things that are the results of this stage, including the form of a product element and the selection of the shape and size of the component.
e) Design details. This stage produces a product document design, so it can be produced continuously with better product development. This product document can include: design concept drawings, detailed drawings, operating systems and standard component selection.
f) Design of wearable chair by using of CATIA software.
g) Kinematics analysis of the Wearable chair to ensure the movements of each component can be known when used.
h) Strength analysis of components by using computer software (ANSYS).

4. MATERIAL SELECTION

The selection of material for different part of a wearable chair for a design it is must that is familiar with the effect during manufacturing process and welding treatment. The Choice of material for engineering purposes depends upon prperties of materials, Suitability of materials for the working condition in service, The cost of materials, Physical and chemical properties of material, Mechanical properties of material.

Sr. No.	Different Parts Used In Wearable Chair	Materials
1	Upper Pad	Mild Steel
2	Lower Pad	Mild Steel
3	SUSPA Air spring damper	Stainless Steel
4	Strap (Belt)	Nylon
5	Shoes holder	ABS (Acrylonitrile butadiene styrene)

5. DESIGN OF PROPOSED MODEL

Design of proposed model (Wearable Chair) draw by using CATIA (V5) software in 3D view by using accurate and proper dimensions design of wearable chair as follow as:

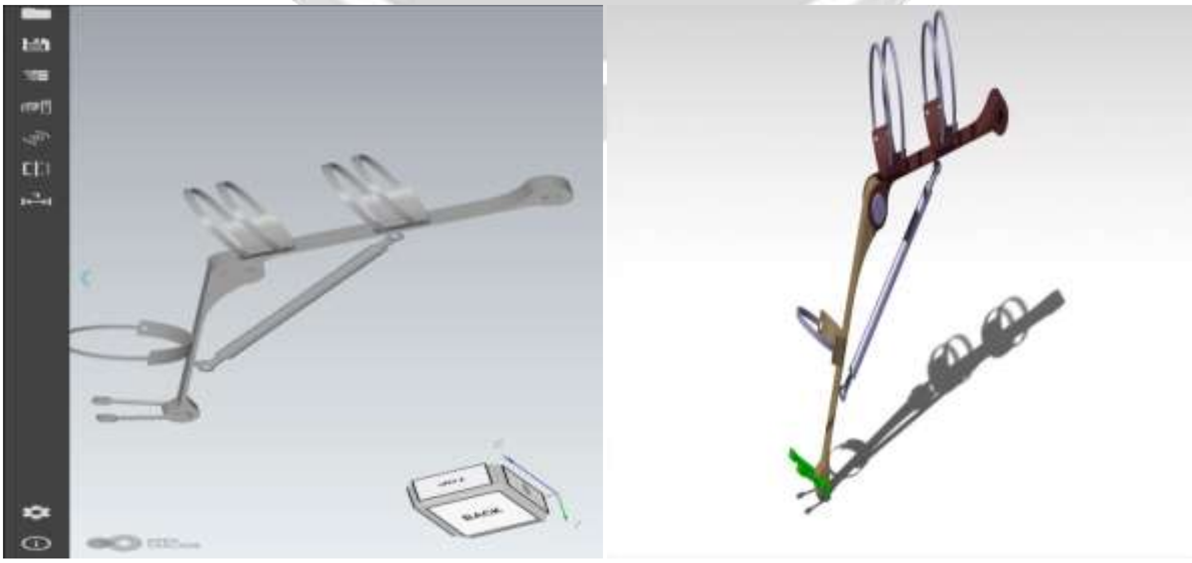

Fig: - 3D model of wearable chair

6. CALCULATIONS

Basic Dimensions:-

Sr. No.	Different Parts Used In Wearable Chair	Dimensions (mm)
1	Upper Pad	400
2	Lower Pad	400
3	Standard SUSPA Gas Spring Damper	413

Force Calculation of SUSPA Air Spring Damper:-

L=Distance between hinge and gas spring of upper pad
D= Distance between hinge and gas spring of lower pad
G= gravity (m*g)
N=Number of gas spring

L= 200mm
D=130.7mm
G=120*9.8
N=2

Force (F) = G*L/D*N

F= 120*9.88*400/261.4*2

F= 1199.69 N

7. ANALYSIS METHODOLOGY

In this section, the modelling and analysis of the wearable chair will be described. The following steps are followed and the analysis is carried.

1. In the ANSYS workbench under the static structural module the project is started.

2. The model is imported into ANSYS.

3. Then the model is meshed and the loading conditions are applied to it.

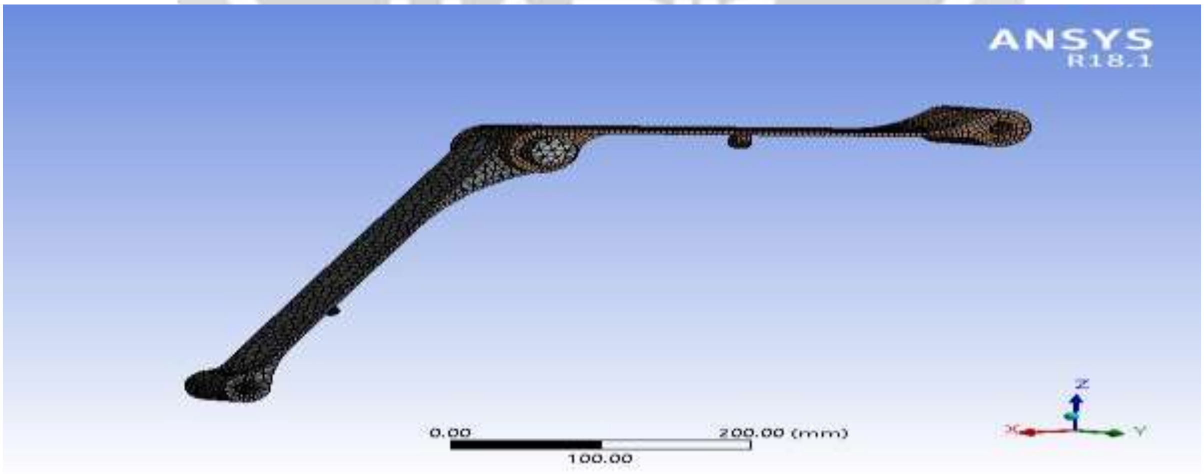

Fig: - Meshed Component

NO. Of Nodes	No. Of Element	Distance Of Mesh
30956	10609	5mm

RESULTS AND DISCUSSIONS:-

The simulated values of deflection and stress for with loads are presented. The experimental results were recorded and shown below

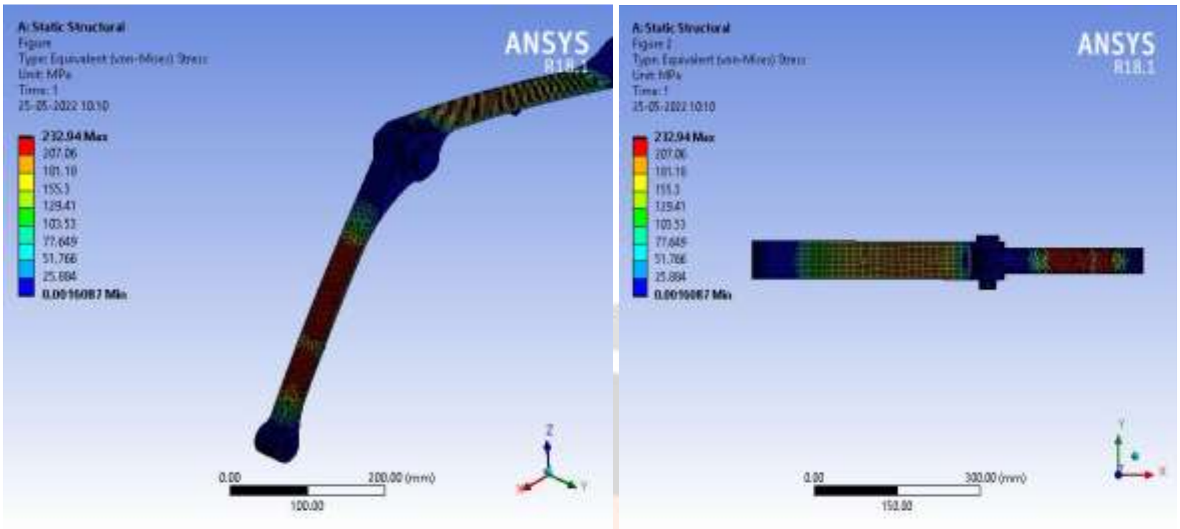

Fig:- Equivalent (Von- Mises)Stress for wearable chair

Equivalent (Von- Mises) Stress	
Minimum (mpa)	Maximum
1.6087e-003	232.94

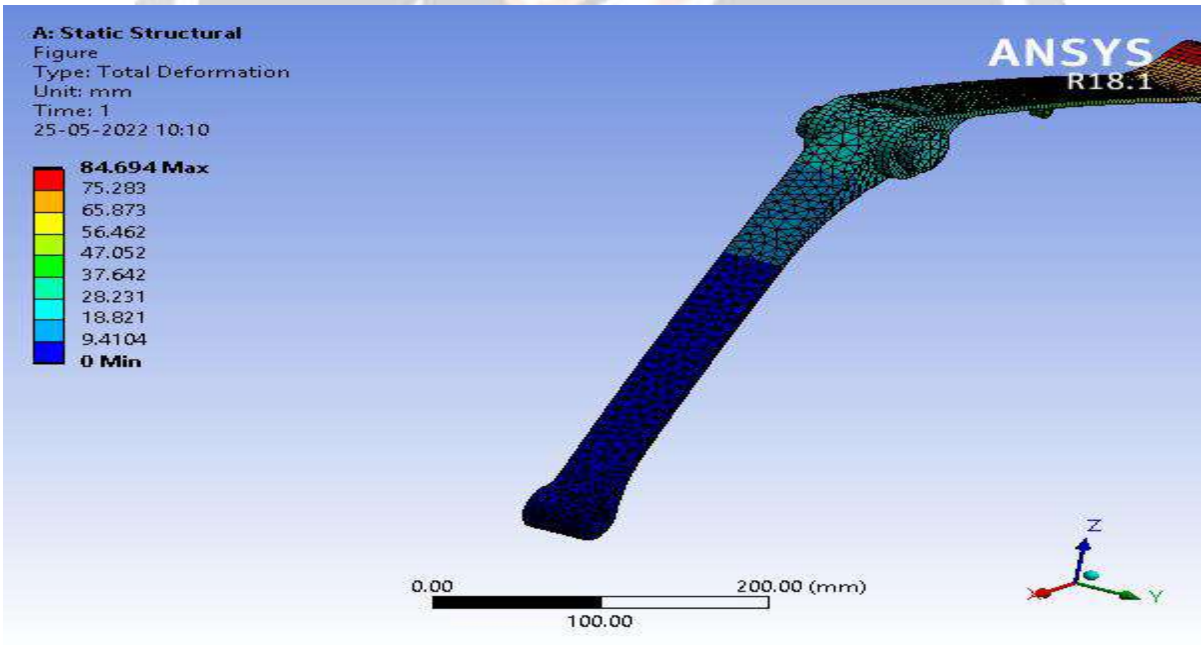

Fig:-Total deformation for wearable chair

Total Deformation	
Minimum (mm)	Maximum (mm)
0	84.694

Factor of safety = Yield stress/Design Stress
Factor of safety =320/232.94
Factor of safety =1.37

7. ADVANTAGES

a) The chair locks itself in place and redirects the person's body weight to its heels.

b) It can support up to 120kg of weight.

c) Apart from allowing the user to walk around while wearing the device, it also allows one to perform some running.

d) Maintain right posture while sitting.

e) Required less space.

f) Attractive in design and smooth in operation.

8.Application

Wearable chair is widely applicable in assembly line in industries where workers works for whole day by standing which will cause frequent tiredness and this result low production rate.

Fig: - Practical Application (Assembly Line

9. CONCLUSION

Based on result of the study the design and analysis of wearable chair satisfied the requirement of the objective it will minimize the risk of MSD and leads to the increase in productivity of the industry by reducing worker's fatigue. This result is a reference for the development of wearable chair products that are more suitable for workers especially those relating to the weight of the wearable chair flexibility to move, safety, comfort in its use and low production costs. Hence design is affordable and specially designed for the people at different assembly line work due to this arrangement peoples felt relaxed who were suffering from the back pain and spinal cord diseases.

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