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DESIGN AND FABRICATION OF PNEUMATICALLY OPERATED HUMAN EXOSKELETON

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Abstract - An exoskeleton, as the name proposes, is an external packaging that can be worn to help the body, either to help a person with overcoming an actual issue or to update their regular cutoff points. The edge gives the appendages greater development, strength, and perseverance because of a pneumatic framework. This venture centers around the displaying, fundamental examination, improvement, and testing of a minimal expense, pneumatically worked chest area Exoskeleton model that is expected explicitly for assistive burden lifting and to help modern specialists in conveying weighty burdens. The model will be created utilizing CATIA. The little, and medium-sized undertakings industry, the auto business, search and salvage tasks, transport and coordinated operations, the clinical business, the development business, and various other limited scope ventures are only a couple of the numerous potential applications. The group has built a wearable model that can lift around 12 kilograms for each arm with progress. A 5/2 DC valve has been particularly utilized for development and withdrawal of the arms. The Exoskeleton model's exhibition is being advanced and its lifting limit, portability, adaptability, and controlled synchronized lifting are being improved.

Key Words: Human exoskeleton, Pneumatic, Load lifting, 5/2 DC Valve, Flexibility.

1. INTRODUCTION

A hard, outer skeleton that covers the beyond an organic entity's body and gives insurance, backing, and construction is known as an exoskeleton. In science, arthropods, alongside different creatures like a few mollusks and echinoderms, regularly have an exoskeleton.

Exoskeleton are routinely made of a serious, guarded material, for instance, chitin or calcium carbonate, and are isolated into sections or plated, which think about versatility and advancement. The life form can move its appendages and body since muscle is connected to within the exoskeleton.

Lately, modelers and analysts have in like manner advanced exoskeleton foe use by individuals called as human exoskeletons. A human exoskeleton is a wearable device that offers external assistance increment to the client's body. It is expected to assist individuals with versatility hindrances like strong dystrophy or spinal rope wounds as well as to work on actual execution and portability.

Human exoskeleton regularly includes an edge or development that is associated with the client's body by and large at the arm, hips and legs, and contains motor or other mechanical parts that give assistance or insurance from advancement. The exoskeleton can invigorate the client more, perseverance, and steadiness and can be constrained by the client or a PC. Human exoskeletons can be separated into three classifications: full-body exoskeleton, lower-body exoskeleton, and chest area exoskeleton.

The central point of convergence of this endeavor is to extend the strength of body for really troublesome work. Outer muscle wounds (MSIs), like injuries, strains, and different wounds, can come about because of lifting, dealing with, or conveying objects at work. At the point when abnormal stances, bowing, contorting, and weighty burdens are involved, the gamble of injury goes up. A pneumatically controlled human exoskeleton is utilized to lessen the dangers related with lifting the weighty burden.

2. PROBLEM DEFINITION

The issue being tended to by the pneumatic human exoskeleton is the gamble of outer muscle wounds that emerge from truly requesting undertakings, like hard work and physical work. These wounds can bring about lost work time, diminished efficiency, and long haul incapacity.

The exoskeleton means to offer outer help and expansion to the client's body, lessening the gamble of injury and improving actual execution, especially for assignments including weighty burdens. Another issue that the exoskeleton might address is the weakness and strain related with truly requesting assignments, which can influence the client's general wellbeing and prosperity.

All the more no of people influences critical expansion in labor cost of the association. Exoskeletons assumes significant part in disseminating same measure of work over the diminished no of human representatives.

3. OBJECTIVES

1. To plan and create pneumatically worked exoskeleton for lifting significant burden.
2. To diminish stress on the body.
3. To guarantee that the exoskeleton is financially savvy and accessible to the general masses.
4. To make a financial, convenient, solid, steady and ergonomic human exoskeleton arm.

4. CAD MODEL AND ANALYSIS

4.1 CAD model

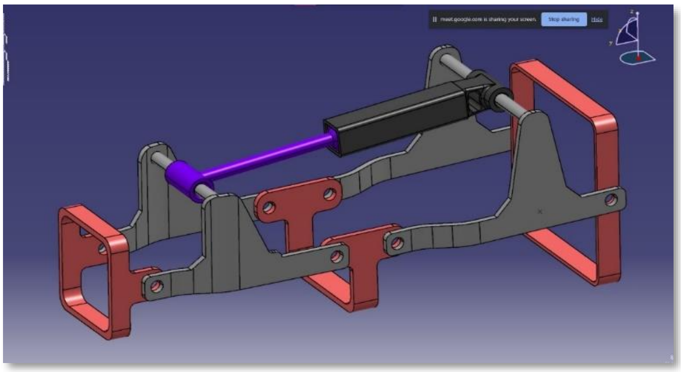

Fig. 4.1.1 Assembly of exoskeleton for arm

4.2 Analysis

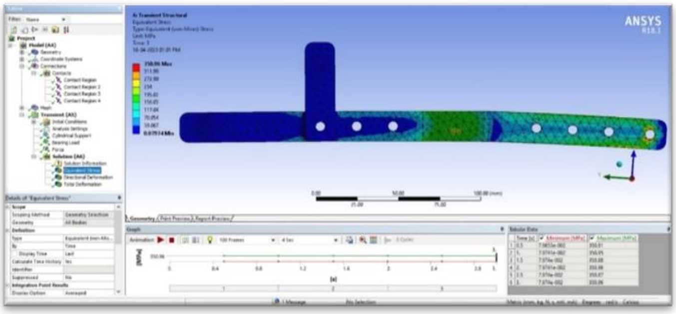

Fig. 4.2.1 Equivalent stresses

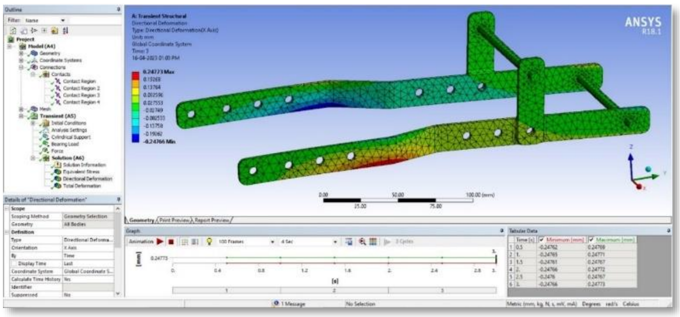

Fig. 4.2.2 Directional Deformation

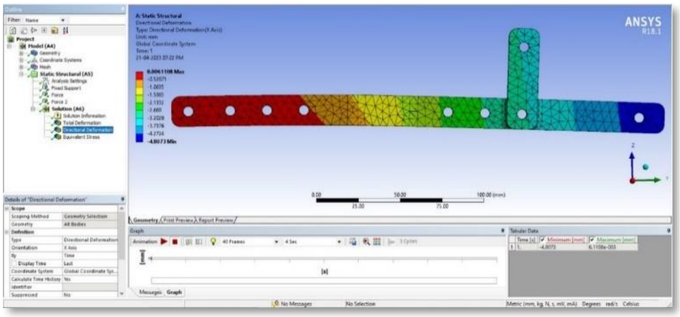

Fig. 4.2.3 Directional Deformation (Single side)

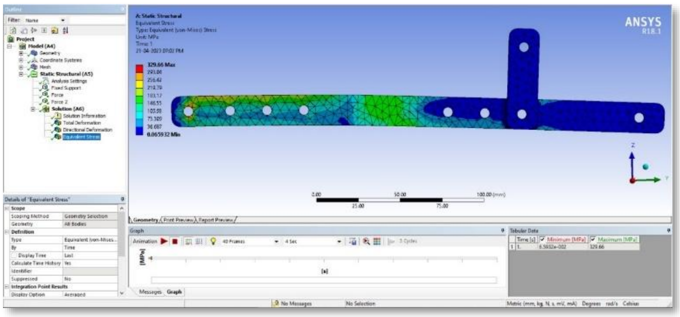

Fig. 4.2.4 Equivalent (von- Mises) stresses

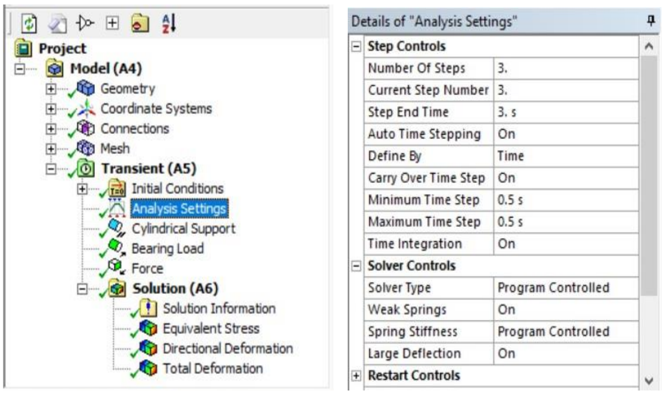

Fig. 4.2.5 Analysis settings

Table 4.2.1 Force analysis table

Name Of the Component	Type Of Stress	Deformation Value	Analysis Value	Permitted Value (Tensile)	Design Safe / Not Safe
Forearms assembly arrangement	Equivalent stress (MPa)	-	350.96	400-550	Safe
	Total deformation (mm)	4.20	-	-	Safe
	Directional deformation (mm)	0.247	-	-	Safe
Forearms Single Side Plate	Equivalent Stress (MPa)	-	329.66	400-550	Safe
	Total deformation (mm)	6.055	-	-	Safe
	Directional deformation (mm)	0.061	-	-	Safe

5. CALCULATIONS

P = Inlet pressure
= 3 bars
= 0.3 N/mm^2

F1 & F2 = Force lifted by left arm and right arm

A = Area of cylinder
$= \frac{\pi}{4} \times D^2$

D = Bore diameter of the cylinder
= 25 mm

Pressure $= \frac{Force}{Area}$

P $= \frac{F1}{\frac{\pi}{4} \times D^2}$

0.3 $= \frac{F1}{\frac{\pi}{4} \times 25^2}$

F1 $= 0.3 \times \frac{\pi}{4} \times 25^2$
$= 147.26 \text{ N} \cong 148\ N$

F1 = 15.1 kg

Force applied for both arms is same
F1 = F2 = 15.1

Total force generated on the system (F)
F = F1 + F2
= 15.1+15.1
F = 30.2 kg

Cylinder front end holder:

d = Diameter of rod at cylinder front end = 8 mm

$\sigma = \frac{F}{A}$

$= \frac{F}{\frac{\pi}{4} \times d^2}$

$= \frac{148}{\frac{\pi}{4} \times 8^2}$

σ =2.92 N/mm^2

$\sigma_{analysis} > \sigma$

Hence, Design is safe.

Cylinder rear end holder:

D = Diameter of rod at cylinder front end = 8 mm

$\sigma = \frac{F}{A}$

$= \frac{F}{\frac{\pi}{4} \times d^2}$

$= \frac{148}{\frac{\pi}{4} \times 8^2}$

σ =2.92 N/mm^2

$\sigma_{analysis} > \sigma$

Hence, Design is safe.

6. EXPERIMENTAL SETUP

Fig. 6.1 Testing of the project- Extended Position

Fig. 6.2 Testing of the project- Retracted Position

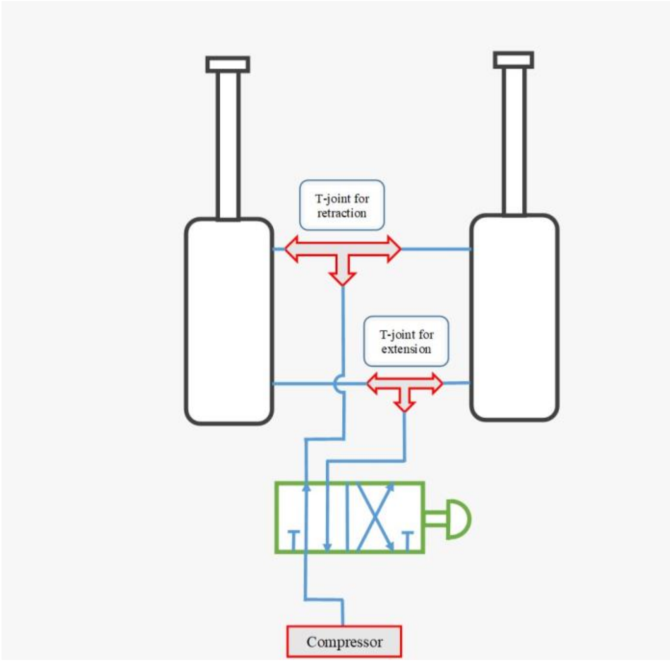

Fig. 6.3 Pneumatic connection

7. CONCLUSIONS

Project has been manufactured considering an objective to lift the heap of 30 kg of weight. Nonetheless, the plan contemplations were made for certain suppositions. This ultimately influences the estimation factors. Consequently, the outcome contain lesser qualities than the proposed weight training. The weight at present lifted is around 25 kilograms. Nonetheless, the component stirring has been sufficient. It's been filling in true to form and at its finished usefulness. In any case, further enhancements can grow its cutoff points. Expanding tensions and decreasing spillage pressure drops in framework can decidedly influence the effectiveness of the task.

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