Result On Design And Development of Exoskeleton Power Suite

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ABSTRACT

The future of technology lies significantly in the field of R&D. With extensive research and the desire to obtain abilities beyond the human capability, the concept of anthropomorphic equipment came into being. The thirst for indomitable power was quenched by the development of the " Exoskeleton." A Exoskeleton also known as Powered Arm, Exoframe, or Exosuit, is a wearable mobile machine that can be powered by a system of motors, pneumatics, levers that amplifies the force of the operator and enables them to possess superhuman strength. This concept has a wide scope for improvement and is a tantalizing topic for research. With the dawn of this advanced technology, the term 'weakness' can be eliminated from the human perception. This project aims to empower the physically weak individuals by helping them harness the power of pneumatics to amplify the strength of their arm. By incorporating a pneumatic cylinder in the system, it is possible to significantly reduce the amount of muscle effort required, by an individual, while lifting loads up to twenty-five kilograms. The design has been realised for one arm but can be extended to the other arm as well. The exoskeleton arm is a subassembly of an entire portable suit, and it permits the transfer of external loads to the stronger sections of the body by means of accurately placed linkages and joints. The arm is intended to be an auxiliary source of strength for any person willing to exercise themselves back to fitness or just perform arduous domestic tasks.

Keyword: *- Exoskeleton1, pneumatic cylinder2, anthropomorphic equipment3, wearable mobile machine4.*

1.INTRODUCTION -1

It is the type of upper body skeletal structure which is worn over body to perform the function in field. The various components studied while studying the entire mechanical course, by using such components like pneumatic actuators, compressor, valves, circuits, etc. this product is designed. This type of design creates the natural interaction between human and machine where by using such machine the human being can lift the heavy loads easily. It is the system combination of pneumatic cylinder (Double acting), Direction control valve, check valve, flow control valve, compressor and frame. Using this system, the handicapped person can also lift or move the limb which is disabled. It can be also use by soldiers to carry heavy load like missiles etc. All the components are positioned at the back of the structure so that the user feels no restrictions in the motion. Mechanical designs should therefore consider the possibilities of unpredicted erroneous operation of the device controller when the device is actively actuated. Limits to the range of motion can be set using a mechanical stopper or corresponding structural designs. So that the power suit cannot force the wearer's body to move in an excessive range of motion.

2. Objectives -2

1. To reduce the human effort while carrying the heavy loads.

2. To give the limb movement for physically challenged person in daily work.
3. To give the option for user to adjust the frame according to need or size of arm.
4. Controlling the stroke of piston rod according to application of user.
5. Use of material for frame which is economic and light in weight.
6. Study and analysis of various links involved and their failures.
7. Case study.

3. LITERATURE REVIEW -3

Literature survey plays an imported part in formulating any project. There are many papers available for the design and analysis of Pneumatic power suit based on the relevance of the statement of the project. Based on these research papers, a different methodology is chosen which is suitable for design of power suit. The referred papers are explained in brief as below, mentioning the contribution of the author only.

The concept of the pneumatic powered suit and its benefits, theoretical background, design difficulties and the design process was summarized by: -

Nikhil P. Shinde1, Daji S. Shinde1. studied about " Exo-Skeleton Arm Using Pneumatic Cylinder" The concept of the pneumatic exo-skeleton and its benefits was summarized, it is a type of device which can be worn over the human body and carry the load or reduces the human effort. The exo-skeleton arm structure was made mostly from a combination of steel and aluminium. They described application of robotic devices in rehabilitation, robotic system and its main subsystems. This exoskeleton arm is light in weight and has low cost. It uses an aluminium material for frame. It consists pneumatic cylinder, direction control valve and compressor power supply. The main objective of this project is to help workers to carrying heavy load. Such type of robot creates natural interaction between machine and man. One of the important use of exoskeleton enabling a soldier to carry heavy object while climbing stairs or running. They aluminium material is used for frame manufacturing to reduce the weight of material. The compressor used in this project requires 4-8 bar capacity and the ability of compressor to lift weight up to 5- 20kg load. In this four cylinders are used for the operation having stroke length 120mm. The main objective of this project is to develop inexpensive and user friendly system for carrying heavy job in industries.

Gopal Krishna U B1, Prajwal Hosmutt H R2 studied about "Design And Fabrication Of Pneumatic Powered Exoskeleton Suit For Arms" It says all about the powered suit for shoulder rehabilitation. Design process, kinematics actuators, fluid circuits and analysis. The type and process of selection of actuators, which is going to help us lot in this project. This project shows that it is simple in construction, design and cheaper. It gives quick response and flexible compared to hydraulic and electrical type powered suit. It makes physically disabled people to carry weights in their daily life. In industrial application it requires more human resources for daily work and load carrying process. The important parts used in this suit is compressor unit, solenoid valve, double acting cylinder. Direction control valve is used to control the direction of the pressurized air in this pneumatic system. In this project 5/2 fabricated solenoid valve is for right hand. They used mild steel material for the manufacturing of frame. They used hollow pipe with diameter 25mm, actuator having diameter 25mm. They used solenoid valve having three port and two positions. They used air compressor having pressure limit 4-8 bar and controller AC or DC. The capacity of pump used in this suit is 4-8 bar. This project show that it is simple in construction, design

and cheaper. It gives quick response and flexible compared to hydraulic and electrical type exoskeleton. It makes physically disable people to carry weight in their daily life.

Abdulla Almomani, Faisal Miqdadi. studied about "The 1st Pneumatic Fluidic muscles based Exoskeleton Suit" The exoskeleton arm structure was made mostly from a combination of steel and aluminium. The Power system was delivered by a set of fluidic muscle. They also described the application in various fields like civil, medical, society, etc. Provide the proper information of material to be use and motions with human comfort. They provide three degree of freedom for suit. It carries heavy load for long time of period. In this suit used recyclable, light, and enduring material used. They used fluidic muscles in this suit. This muscle is made up of, fluidic tubes are of elastomers, it is reinforced with aramid fibre, a manmade organic polymer. This suit can be used for military use to help solders carry heavy load, firefighters, and other rescue workers survive dangerous environment. It is also use in medical field to allow nurses to heavy patients. In suit they utilized a combination of controllers, sensors and actuator. The defines department of the US expressed their interest in development of power suit of arm or. They used electromyography(EMG) signals, potentiometers for measuring joint angles, force sensors for measuring ground reaction force, a gyroscope and accelerometer for measuring angle.

R. A. R. C. Gopura, Student Member, IEEE, Kazuo Kiguchi, Member, IEEE studied about "Mechanical Designs of Active Upper-Limb Exoskeleton Robots State-of- the-Art and Design Difficulties" Developing proper upper limb exoskeleton has been a challenging task because of challenges imposed by human upper limb specially shoulder complex, so various mechanical designs were studied. Also they described the various controllers for position control of hand. The difficulties were studied while designing the suit, as the upper limb is a one of the complex part of human being. The weight of upper limb robotic system also affects for the portability of the robot. Shoulder join complex is one of the complex area in human body. Its centre of rotation is changing with the motion. The elbow joint is melded as a uniaxial hinge joint, it consists three bones called as humours, ulna and radius. Shoulder joint is melded as a spherical joint and located inside the user's body. PID controller used for position control of hand exoskeleton. Upper limb robotic structure should be biomechanically investigated light weight and efficient power supplies, actuators and transmission are essential to developed upper limb exoskeleton robots.

Hiroshi Kobayashi, Hirokazu Nozaki, and Toshiaki Tsuj. studied about "Development of Power Assist System for Caregiver by Muscle Suit" They used new link mechanism for the shoulder joint which consist of two half circle links with four universal joints. Project main aim was to provide the provision to move the limbs for physically challenged people. This muscle suit consists of a mechanical arm or type frame. The shoulder joint which consist of two half circle links with four universal joints. This suit carries heavy load for long period of time. This project will aid-medical organizations, civil engineering and industry. The joints are not directly rotated with actuators. This system required a compressor, microprocessor and electro-pneumatic regulator. The size and weight of electro-pneumatic regulator are 22*52*58.5mm and 181gm. The total current is less than 30MA. It will be possible to reduce burden for caregiver. This muscle suit is water proof. The purpose of developing muscle suit is for supporting unhealthy people though, when we think of practical use of muscle suit from ethical.

Tadashi Murata*1 Hirohisa Hirai*2 Ken Onishi. studied about "Development of Powered Exoskeleton for Heavy Work - Coexistence of Robot's Power and People's Dexterity" - They developed power suit which carries a load up to 80kg, compact in size and the project was exceed to provide the provision for walking by carrying the load. Also provide information of the metabolic studies and about the human body joints which is used to make the

exoskeleton joints as per human natural joints. A strategy based on state-machine control had written by them based on joint angle and ground-exoskeleton force sensing to control the joint actuation at this exoskeleton hip and knee.

Suresh Talur1, Kiran Kumar.P.2, T. Madhusudhan3 studied about the Selection of Material by weighted property method for Savona's Vertical Axis Wind Turbine Rotor Blade in this presentation we studied the weighted point method how to use it in real life problem. They described about the weighted point method and how to use it to select the appropriate material for desired application. It was very useful to us to select the frame material for powered suit in our application. Selection of material is very important procedure before detail design of product. In this paper suitable material is selected for frame of powered suit by Weighted Point Method, for manufacturing of powered suit),material considered for manufacturing of powered suit are aluminium (7020 Alloy), aluminium (1060 alloy), Mild Steel (grade 55), Stainless Steel, among these optimized material should be selected to increase performance of powered suit , the selected materials for powered suit must shows low density, corrosion resistant, economic, good machinability and good mechanical properties.

S. R. Kamat1 , N. E. N. Md Zula1 , N. S. Rayme1 , S. Shamsuddin1 and K. Husain2 studied about the "The Ergonomics Body Posture on Repetitive and Heavy Lifting Activities of Workers in Aerospace Manufacturing Warehouse" The main idea of this study is to investigate and improve the ergonomics working postures of the workers working in the warehouse which focused on the task related to manual lifting activities. The current working body postures was analysed using CATIA V5 software application to identify whether the working body postures to identify the possible areas of improvement that can be made to reduce the ergonomic risk factor and to reduce the risk of musculoskeletal disorder among the workers. From the RULA analysis by the CATIA V5, even though the posture of the workers is improved by changing the posture, the score is still 7 and its convey a risk of getting ergonomic injuries because of the load of the task is still heavy and repetitions of work still occurs. However, when a design of helping device is added into the working environment, the score of RULA is decreases from 7 to 2. Thus, proved that the suggested working posture and helping device are required in order to reduce the risk of getting ergonomic injuries. Warehouse is an important entity in manufacturing organizations. It usually involves working activities that relate ergonomics risk factors including repetitive and heavy lifting activities. Aerospace manufacturing workers are prone of having musculoskeletal disorder (MSD) problems because of the manual handling activities. All those symptoms and effects will greatly contribute to repetitive stress injuries (RSIs) and musculoskeletal disorder (MSDs).

Biswa Bhusan Mohanty[1], Divya Agrawal[1], Kunal Mishra[2], PusparajSamantsinghar[3], Prafulla k. Chinara[1,] "Estimation of height of an individual from forearm length on the population of Eastern India" in this paper they studied about the estimation of height of an individual from forearm length on the population of Eastern India. Height is fundamental unit to access growth and nutrition for calculating body surface area in a person. In these cases, to measure height of a person. The main aim of this project is to find out a regression equation that could calculate the height of person and reproducibility from forearm length. While calculating the regression equation, it is found that there exists a linear relationship between the height and forearm length. The regression equation derived from this study can be applied reliability for estimation of stature. Hence it is possible to determine the height of a person by using the data and formulae derived from the present study. The average height of adult males within a population is significantly higher than that of adult females. From this study we understand that the height increases the forearm length of the both male and female also increases.

4. DESIGN AND DEVELOPMENT

4.1 Design Solid Model of Power Suit:

For designing the solid model, we used CAD software namely SolidWorks. Procedure for designing the solid model as follow:

1. Prepare 2D conceptual sketch
2. Convert 2D sketch into 3D solid Model ❍Modify existing 3D Model

4.1 Conceptual Design:

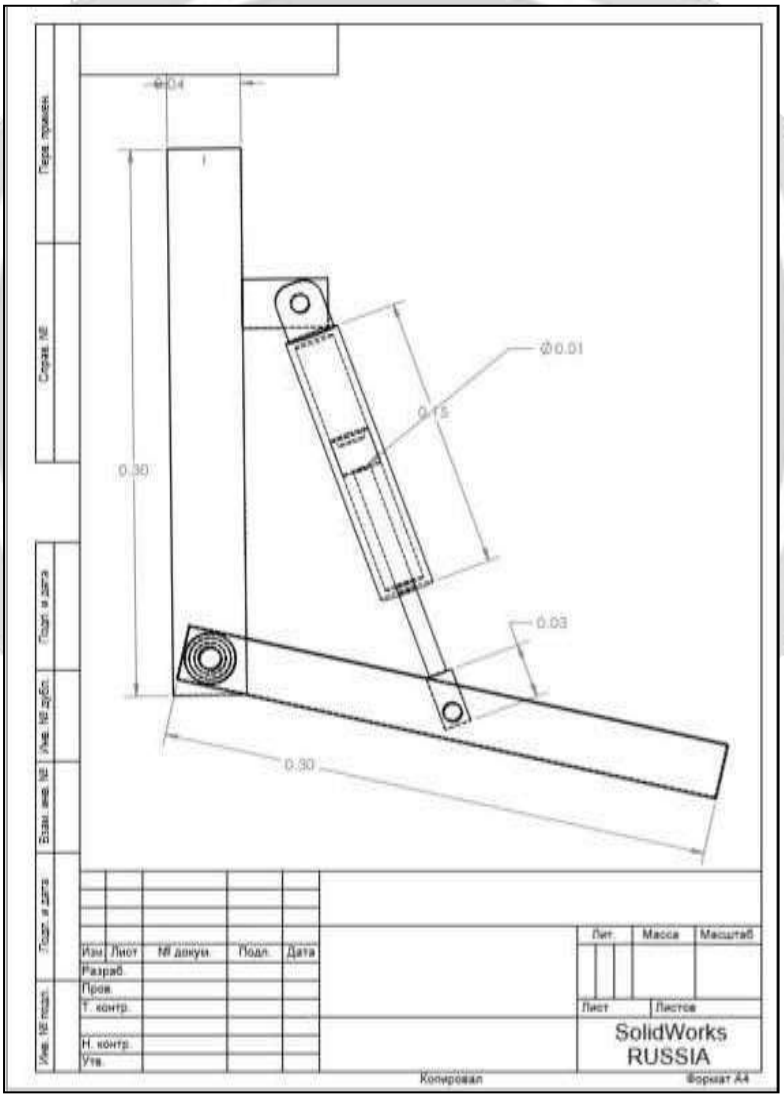


Fig. 4.1: Conceptual design

4.1.1 Design Stages:

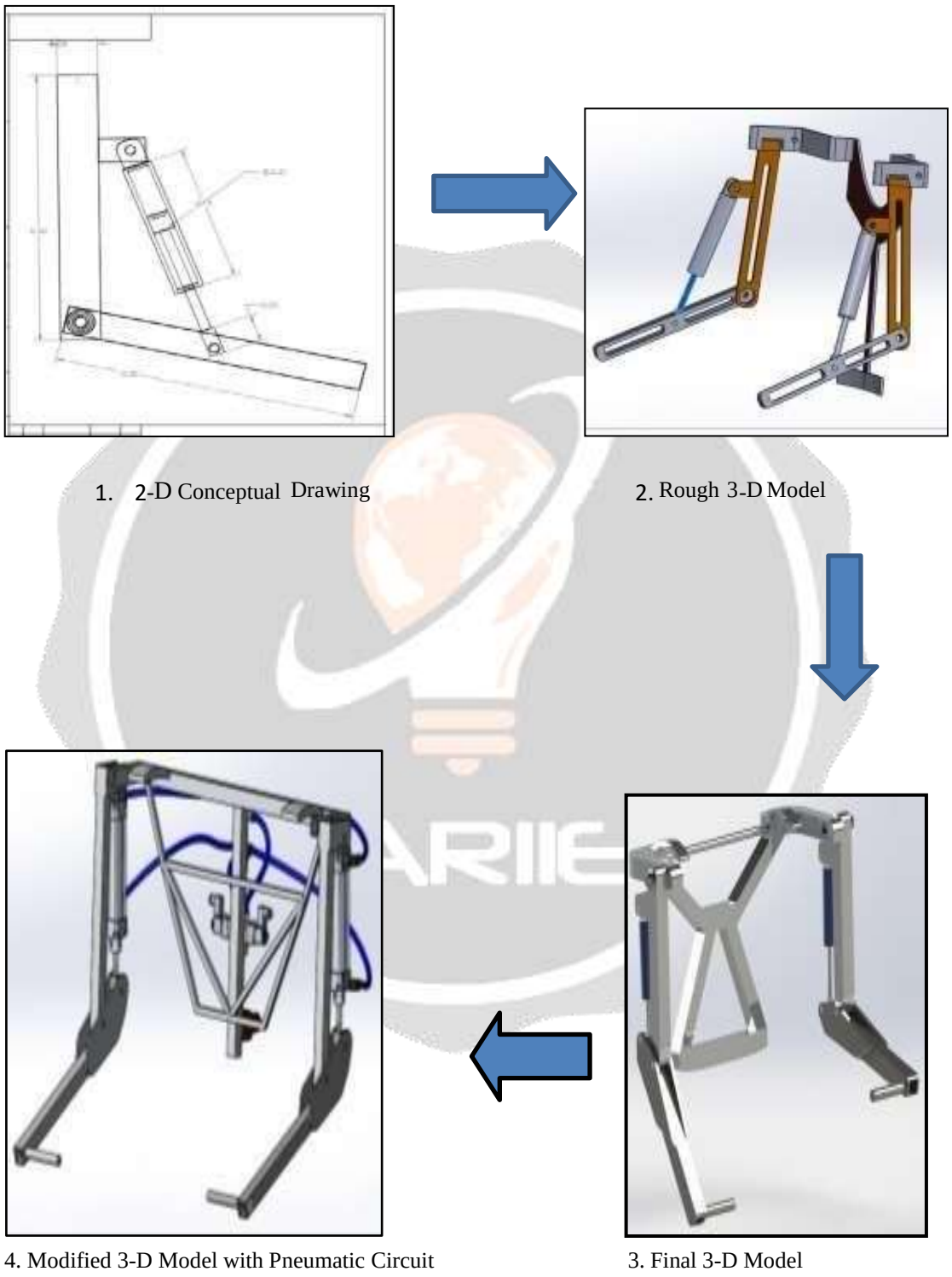


Fig.4.1.1: Design stages

4.1.2 Final developed project design**:**

Fig.4.1.2.1 Isometric View

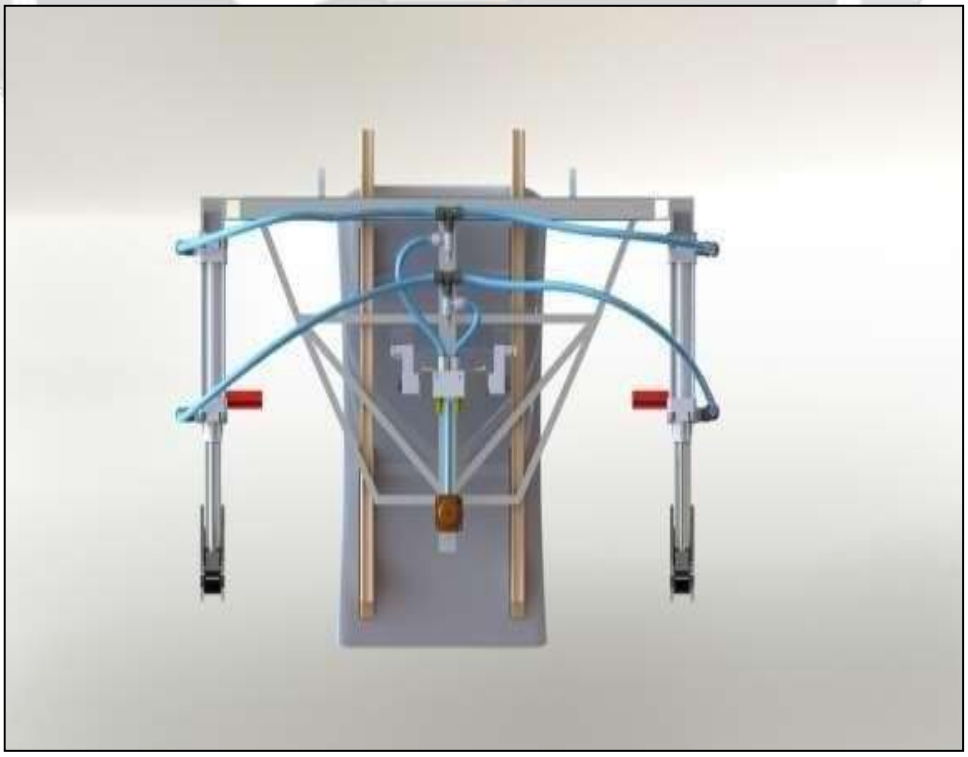
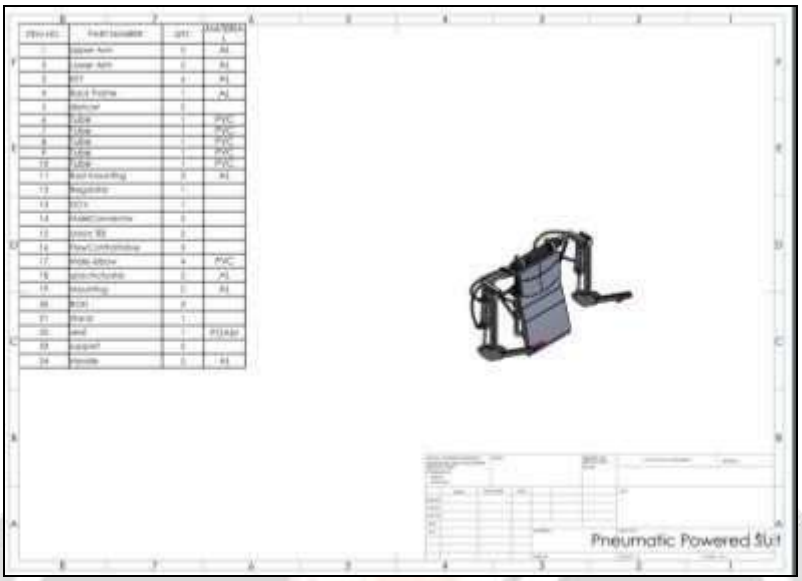


Fig.4.1.2.2: Back side view

4.1.3 Drawing Sheet:



4. CONCLUSION

From this project we can conclude that, If we use pneumatic power suit while carrying heavy load in small scale industries, we can avoid the accidents of workers and we can reduce the injuries of workers. It is economical and simple system as compared to other techniques such as hydraulic, electric system etc. This system also useful for physically challenged person for limb movement in daily work. While during manufacturing of the project we studied about the human ergonomics and care should we taken while carrying heavy load. In this project we use weighted point method for material selection. In this project we effectively used various software like, we use CAD software **Solid Works** for 3D model design during this design we studied different parameters like part modelling tools, assembly tools, rendering etc. in software during design a product. We use **FlexSim** software for design a pneumatic circuit. It is stimulated software for design a pneumatic circuit. We also understand different pneumatic components and its specification. For the purpose of the calculation we used **Mat lab** software. By using programming, we make our calculation easier and simpler.

5. REFERENCES

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