DESIGN, ANALYSIS AND FABRICATION OF PORTABLE PNEUMATIC VICE

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ABSTRACT

Pneumatic systems are safer than electromotive systems because they can work in inflammable environment without causing fire or explosion. Apart from that, overloading in pneumatic system will only lead to sliding or cessation of operation. Unlike electromotive components, pneumatic components do not burn or get overheated when overloaded. The operation of pneumatic systems does not produce pollutants. The air released is also processed in special ways. Therefore, pneumatic systems can work in environments that demand high level of cleanliness. One example is the production lines of integrated circuits.

INTRODUCTION

Here we have designed a pneumatic vice in catia software and done structural analysis using Ansys software and also fabricated the model.

There are three major types of work holding devices which are:

Mechanical type
Hydraulic type
Pneumatic type

In mechanical type, the screw rod is actuating the movable jaw. One end is connected to the movable jaw and it passes through a fixed type nut. When we rotate one end of the screw rod it will rotate in the nut and in turn moves the movable jaw. Here the rotary motion is converted into reciprocating motion.In Hydraulic type's one end of the piston rod is connected to the movable jaw and the piston slides in the cylinder. Here the hydraulic fluid actuates the movement of the piston; this in turn actuates the movable jaw. Here the principal movement is only a reciprocating movement. Pneumatic type is same as the hydraulic type. Here instead of hydraulic fluid, air is used.An incredible range of manufacturing systems use the force and power of fluids such as water, oil and air. Powered clamps open and close with the force of pressurized air or oil, large presses shape and form metal with hydraulic pressure, and assembly torque tools fasten components with pressurized air. In each example, fluid power provides the energy necessary to exert significant mechanical forces. Systems that use air are called pneumatic systems while systems that use liquids like oil or water are called hydraulic system. The pneumatic systems will be the subject of the first three sessions in the course starting from this session. Pneumatics is all about using compressed air to make a process happens. Compressed air is simply the air we breathe squeezed into a small space under pressure. You might remember that air under pressure possesses potential energy which can be released to do useful work. Their principle of operation is similar to that of the hydraulic power systems. An air compressor converts the mechanical energy of the prime mover into, mainly, pressure energy of the compressed air. This transformation facilitates the transmission, storage, and control of energy. After compression, the compressed air should be prepared for use.

LITERATURE REVIEW

A portable pneumatic vise is a tool used for clamping and holding materials in place during machining, welding, or other industrial processes. To better understand the design and implementation of such a tool, a literature review of relevant studies and articles is necessary.

Here are some key findings from the literature:

1.Design and Analysis of Pneumatic Vise for Heavy Duty Applications (Rajasekhara, K. Gopalakrishnan, and V. Dharma lingam, 2017): This study proposed a design for a pneumatic vise capable of holding heavy loads, up to 2500 kg, using a four-bar mechanism. The authors used Finite Element Analysis (FEA) to evaluate the stress distribution and deformation of the vise under load. They found that the proposed design was effective in reducing stress concentrations and improving the clamping force.

2. Experimental Analysis of a Pneumatic Vise for Sheet Metal Working (R. Corrado, M. Giardina, and M. Zappalorto, 2014): This study evaluated the performance of a pneumatic vise designed for holding sheet metal during stamping and bending operations. The authors tested the vise under different operating conditions and found that it was effective in reducing the deformation of the sheet metal and improving the accuracy of the machining process.

3. Design and Development of a Portable Pneumatic Vise (K. B. Prakash, M. V. Chandrashekar, and P. C. Vinod, 2016): This study proposed a design for a portable pneumatic vise that could be easily moved between different workstations. The authors used SolidWorks software to model and simulate the vise's behavior under different loads and operating conditions. They found that the proposed design was effective in providing a high clamping force while remaining lightweight and easy to move.

4. Development of Pneumatic Vise for Drilling Operation (K. P. Prakash and B. K. Vinay, 2019): This study proposed a design for a pneumatic vise specifically for holding drill bits during drilling operations. The authors used a three-dimensional model to simulate the behavior of the vise under different loads and operating conditions. They found that the proposed design was effective in reducing the vibrations and improving the accuracy of the drilling process.

WORKING OPERATION

Initially starting with air compresses, its function is to compress air from a low inlet pressure (usually atmospheric) to a higher-pressure level. This is an accomplished by reducing the volume of the air.
Air compressors are generally positive displacement units and are either of the reciprocating piston type or the rotary screw or rotary vane types. The air compressor used here is a typically small sized, two-stage compressor unit. It also consists of a compressed air tank, electric rotor and pulley drive, pressure controls and instruments for quick hook up and use. The pressure exceeds the designed pressure of the receiver a release value provided releases the excesses air and thus stays a head of any hazards to take place.

The compressed air goes to the solenoid valve through flow control valve. The flow control valve is used to control the amount air flow to the cylinder. This flow is adjusted by manually by the nap is fixed above the flow control valve. Then this air goes to the 5/2 solenoid valve. The 5/2 solenoid valve is having one input port, two output port and two exhaust port. The 5/2 solenoid valve is controlled by the electronic timing control unit. The speed of the on/off the solenoid valve is controlled by this timing control unit. The 2 outlet ports are connected to an actuator (Cylinder). The pneumatic activates is a double acting, single rod cylinder. The cylinder output is coupled to further purpose. The piston end has an air horning effect to prevent sudden thrust at extreme ends.

TYPES OF CAD SOFTWARE

2D Cad

Two-dimensional, or 2D, CAD is used to create flat drawings of products and structures. Objects created in 2D CAD are made up of lines, circles, ovals, slots and curves. 2D CAD programs usually include a library of geometric images; the ability to create Bezier curves, splines and polylines; the ability to define hatching patterns; and the ability to provide a bill of materials generation. Among the most popular 2D CAD programs are AutoCAD, CADkey, CADDS 5, and Medusa.

3D Cad

Three-dimensional (3D) CAD programs come in a wide variety of types, intended for different applications and levels of detail. Overall, 3D CAD programs create a realistic model of what the design object will look like, allowing designers to solve potential problems earlier and with lower production costs. Some 3D CAD programs include Autodesk Inventor, CoCreate Solid Designer, Pro/Engineer Solid Edge, SolidWorks, Unigraphics NX and VX CAD, CATIA V5.

3D Wireframe and Surface Modeling

CAD programs that feature 3D wireframe and surface modeling create a skeleton-like inner structure of the object being modeled. A surface is added on later. These types of CAD models are difficult to translate into other software and are therefore rarely used anymore.

FINITE ELEMENT ANALYSIS

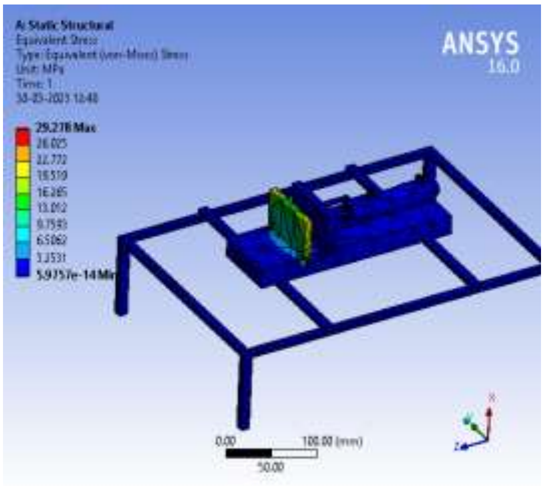
INTRODUCTION TO FINITE ELEMENT ANALYSIS(FEA)

Finite Element Analysis (FEA) was first developed in 1943 by R. Courant, who utilized the Ritz method of numerical analysis and minimization of variational calculus to obtain approximate solutions to vibration systems. Shortly thereafter, a paper published in 1956 by M. J. Turner, R. W. Clough, H. C. Martin, and L. J. Top established a broader definition of numerical analysis. The paper centered on the "stiffness and deflection of complex structures". FEA consists of a computer model of a material or design that is stressed and analyzed for specific results. It is used in new product design, and existing product refinement. A company is able to verify a proposed design will be able to perform to the client's specifications prior to manufacturing or construction. Modifying an existing product or structure is utilized to qualify the product or structure for a new service condition. In case of structural failure, FEA may be used to help determine the design modifications to meet the new condition. There are generally two types of analysis that are used in industry: 2-D modeling, and 3-D modeling. While 2-D modeling conserves simplicity and allows the analysis to be run on a relatively normal computer, it tends to yield less accurate results. 3-D modeling, however, produces more accurate results while sacrificing the ability to run on all but the fastest computers effectively. Within each of these modeling schemes, the programmer can insert numerous algorithms (functions) which may make the system behave linearly or non-linearly. Linear systems are far less complex and generally do not take into account plastic deformation. Non-linear systems do account for plastic deformation, and many also are capable of testing a material all the way to fracture.

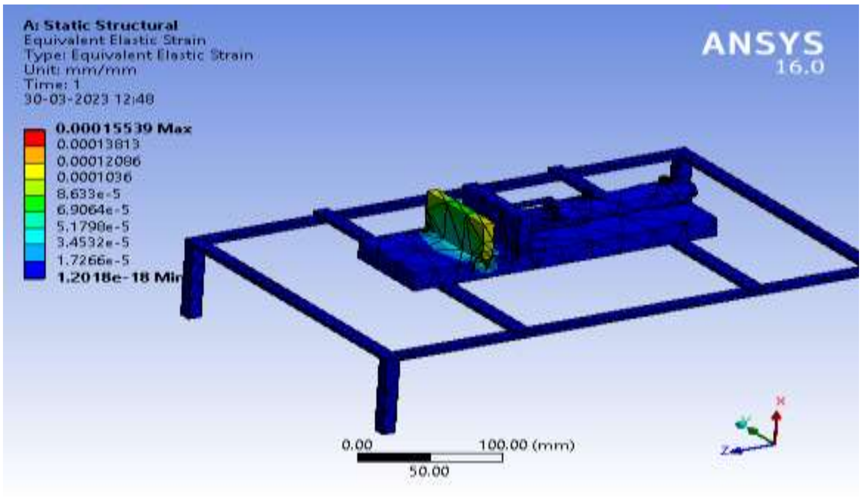
SIMULATION RESULTS

Stainless steel

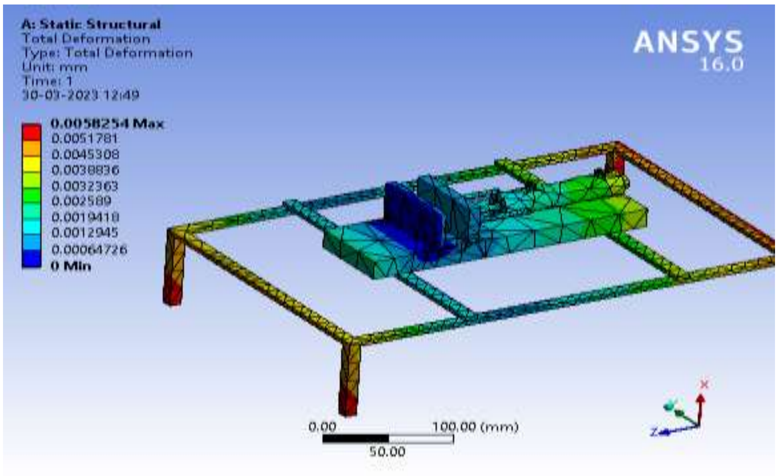
Stress:



Strain:

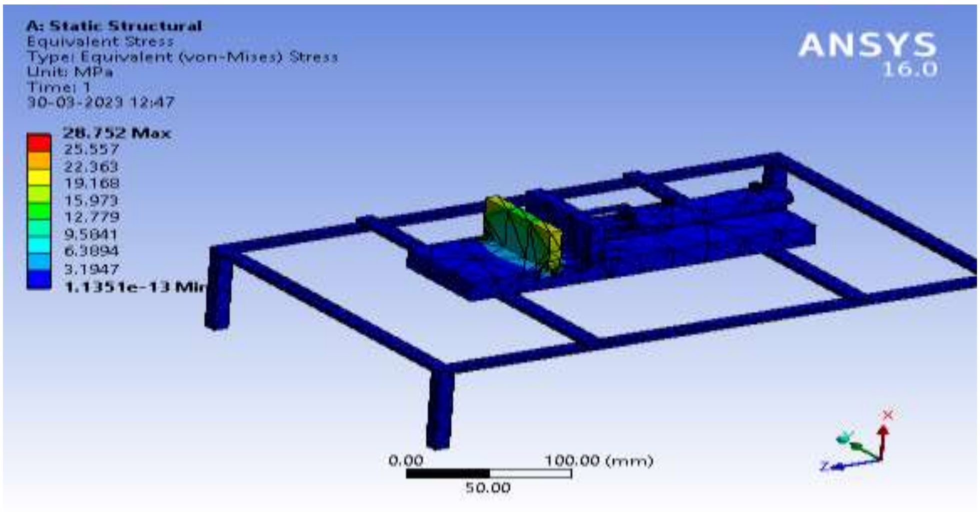


Deformation:



Structural steel

Strain:



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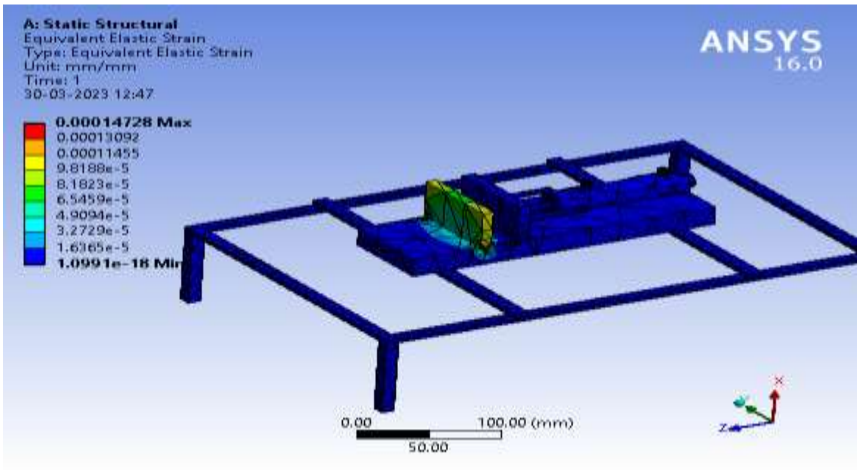

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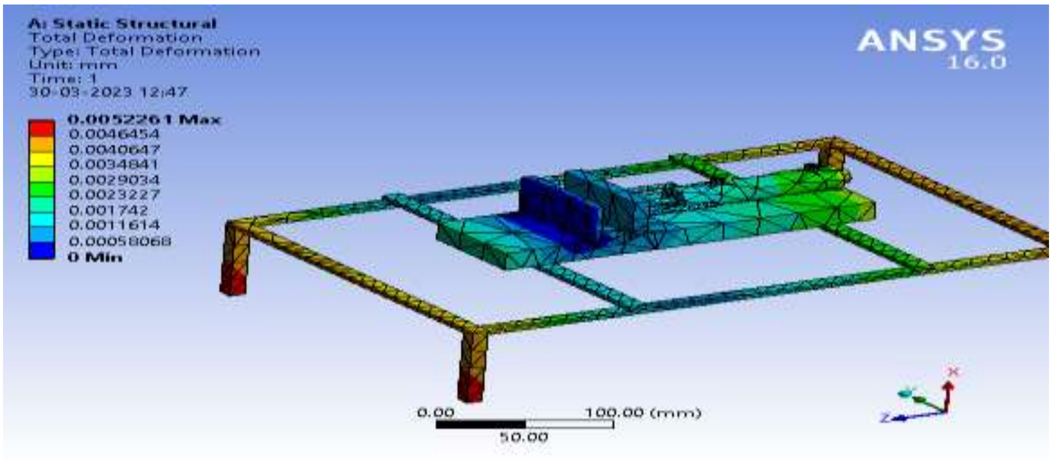

FUTURE SCOPE OF TECHNOLOGY

Some species of sharks must constantly swim to keep water flowing over their gills to stay alive. That same concept also tends to apply to technology- once a technology stops evolving and moving forward, it's on its way to extinction. Fortunately for those responsible for designing and maintaining the pneumatic systems found throughout industrial environments, new sensing and data communications solutions are making pneumatics smarter and simpler to integrate into the Industrial Internet of Things (IIoT). The future of pneumatics will be linked with the expansion of smart sensing technology. Cost-effective sensing and information processing equipment is now becoming part of all types of fluid power equipment, from connectors, tubing, and hoses, to pneumatic cylinders, actuators, and filters. The latest sensor technologies available for fluid power systems make their predecessors seem unsophisticated by comparison. Once, traditional solenoid valves were operated by simple contactors in an output card. Today, network-enabled devices offer built-in diagnostics sensing for monitoring temperature, voltage, current, and sometimes even cycle counts. These sensors offer a plant's management team an almost overwhelming amount of data that, if used properly, will allow them to revolutionize the way they operate and maintain their facilities equipment.

For several years, pneumatics manufacturers have been enhancing their devices to make them truly connected, meaning it is now commonplace to have industrial Ethernet and IO-Link interfaces on pneumatic products. This is allowing pneumatic systems to be more closely monitored and measured – both in terms of the fluid and the equipment – which enables end users to be better informed about performance attributes such as movement, positioning, and flow. However, increases in connectivity and communication system maturity has meant that industry is now seeing fieldbus protocols being superseded by Industrial Ethernet. While protocol connectivity provides a basic level of diagnostics, we are now starting to see an increase in the integration of sensors, allowing current system performance to be monitored, while also offering indications about future failure modes. For example, more and more historical machine data being stored, and algorithms are being used to uncover trends and make informed future predictions. This progression is allowing users to benefit from enhanced measurement, monitoring and control data. This informs strategic decision-making around machine performance and supports both predictive and preventative maintenance objectives, meaning operational efficiencies can be increased and productivity targets met.

CONCLUSION

Hence the pneumatic cylinder has been designed in catia 3d software , Catia helps in designing our concept in 3d and helps in producing drawings We have done analysis in structural analysis using ansys software using Gray cast Iron and Stainless Steel and structural steel , The end results we got are stress, strain and deformation values are less for Gray Cast Iron compared to other two materials

Also,we have fabricated the model and this model can be carried anywhere to the workplace

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