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MECHANICAL DESIGN AND ANALYSIS OF AUTOMATIC PIPE BENDING MACHINE

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Abstract: *Pipe bending is the metal forming processes used to permanently form pipes or tubing. One has to differentiate between form-bound (secure with a cover of bending) and freeform bending procedures, as well as between supported and cold forming procedures. Form bound bending procedures like "press bending" or "rotary draw bending" is used to form the work piece into the shape of a die. Straight tube stock can be formed using a bending machine to create a variety of single or multiple bends and to shape the piece into the desired form. This process can be used to form complex shapes out of different types of ductile metal tubing. Freeform-bending processes, like three-roll-push bending, shape the work piece kinematically, thus the bending contour is not dependent on the tool geometry. The main aim of this project is composition of deformation in tube or pipe bending theory and the effects of Pipe bending machine parts including; clamp die, bend die and support die to obtain optimum bending requirements. Deformation of tubes can be achieved in numerous ways. This bend shaping requires sensitive operation on each component to ensure regularity of production processes with high quality end-product. However it brings some troubleshooting like wrinkling; spring back, breakage and validation. This failure depends on geometry of the material such as bending radius, tube thickness and also friction factor between dies and the tube. Effects of all parameters should be examined before generating the theory for a best solution. Therefore, prediction of the required moment for the proper bending process with low cost and shortened production time is needed. The solid model is generated in Catia V5. Then the model is imported to Ansys through Iges format. The quality mesh is prepared in Ansys for converged solution (analysis package with high optimizing results).*

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I- INTRODUCTION

Tube bending is an item that most people think little about. Other than the obvious exhaust pipe or water lines, many do not know what it is used for. Yet each day they travel by planes, trains and automobiles to their homes. Here they find comfort using the gas range and furnace, sitting in comfortable lawn and kitchen chairs, or loading the dishwasher after eating out of their refrigerators. All are made available by the use of tubing. Lightweight and practical tubing is used by almost everyone in the world every day, but where was tubing only a few short years ago?

We would never think of tubing as being of the metal industry, but truly tubing is relatively new. But nowhere do you hear about tubing. To move water, solid rock was hollowed out or aqueducts (A bridge like structure supporting a conduit or canal passing over a river or low ground.) were built. There was no need for gas lines and oil still came from whales. People are used furnace process of making malleable low carbon steel in 1926 allowed steel to be rolled practically into a hollow bar.

Adding the technology of electric arc welding we had a method to produce tubing economically. Today we call this method Cold Rolled Electric Welded steel tubing (CREW), or if using hot roll steel (HREW). That means electric weld tubing has only been around for 75 years. Truly we have few DOT-COMS of the tubing industry.

Objectives

Design Objectives:

In this project, wrinkling and cross section distortion are the two most severe defects in the tube bending process. Industry practice for eliminating wrinkling is to use a bend die, pressure die along with a clamp die. Clamp die selection depends on the angle of bend material of the tube and the degree of bend. The present research investigates application of only bending tube machine process. For this making complete layout of proto we are going to on the basis of PLM (Project Life Cycle Management or conventional design process) format.

Main goals of this Project:

- Reducing the motor speed ratio for bending a pipe smoothly.
- Selection Of material to be necessary.
- Manufacturing Cost estimation of Rotary Draw Tube bending Machine
- (Working proto type).
- Show working machine with as per required aspects of pipe bending with angle of 26º.

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II - LITERATURE SURVEY

Design And Fabrication Of Pipe Bending Machine Using Hydraulic System; In industry, bending machine with hydraulic system is most commonly used for bending the pipe to the required shape. This system consists of a hydraulic cylinder, ram, die holder. It was operated by hand. Pressurized oil supplied to cylinder using ram (hydraulic). Piston and connecting rod is situated in cylinder. Ram was placed at the top of the cylinder. To increase the pressure, pressurized oil used which moves the cylinder piston forward. At the die holder pipe is fixed. To move the piston, ram strikes the pipe with some forces. Pipe bending also takes part in making component in automobile, aerospace and power plant industries etc. This pipe bending machine system is completely automated and it is based on microcontroller system, it is less expensive and light in weight. The use of this system can be enhanced in small industries, small workshop holder and also can be used in colleges or institutes for laboratory purpose.

Design of Pipe Bending Machine; The objective of the subject is to make new design of manually and hydraulically operated pipe bending machine and stress acting on pipe after bending of pipe. The pipe bending machine is use to bend pipe in different angle shape and curvature as requirement of work. The machine is useful to bend different thickness Pipe as per the requirement of shop. The machine is fully portable type and less weight and easy to assemble and disassemble. The can operate unskilled operator. Our main objective is useless parts for manufacturing pipe bending machine. And analysis different stress act on pipe using ANSYS Workbench.

Design And Analysis Of Portable Rolling And Bending Machine Using CAD And FEA Tool; Portable Rolling and Bending machine is device which gives the less efforts of man and gives the required work properly of the construction and other metal fabricated areas. The large C-clamp mount attaches to work surfaces up to 2" thick; a rubber base pad protects the mounting surface. The orientation of the jaws is adjusted by a single clamping bar mechanism to provide quick repositioning of the work. Instrument makers will find many uses for this versatile vice. This machine work smoothly and gives proper dimension of the required jobs. Its one end having metal bending and rolling device & another end having Bench vice which is rotating about its Axis and hold work piece at any angle. The base plate is rotating of an angle 360 about its central Axis. This machine is used for heavy duty metals which are used in construction areas and multiple operations are performing on it. It is light in weight and portable attach to any work table in Industries, Workshop and Construction areas

Design and Development of Automatic Bending Machine; Presently, bending machines has tremendous use within the field of workplace. The bending machine is one among the foremost important machine in sheet work shop. It's primarily designed for bending. The bend has been made with the assistance of press which exerts large impact force on the work clamped on the die. Manual bending mach intakes extra time and also take more efforts to bend the work piece. Hence, it takes longer time for production. There's lack of reproducibility, repeatability, and effectiveness. It also fails to satisfy customer satisfaction. So, our aim is that the bending machine is meant in such how that, it works automatically. The automation strategy, when implemented give rise to reduced cycle time, costs and improved product quality.

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A Project Report on Pipe Bending Machine; Mechanical Engineering without production and manufacturing is meaningless. Production and manufacturing process deals with conversion of raw materials inputs to finished products as per required dimension, specification and efficiently using recent technology. The new development and requirements inspired us to think of new improvements in manufacturing field. In our project Pipe Bending Machine various diameters of pipe is being bend with the help of this machine and various shapes is obtained like v-shape, circular, square, channel etc. It is used in various industrial operation such as bending a tube to make coil or sheet metal to make certain shape such as 'V' shape. In this project , a iron rod is efficiently bend for a given power of motor, whose diameter is 2.8 cm. the various pipe bending machines consisting of various dies used for production in Industries are known in this project.

III - MATHAMETICAL CALCULATIONS

Mathematical Calculations of Gear Ratio

A type of gear that has straight, flat-topped teeth set parallel to the shaft. Spur gears are the most common type of gears used in industry. a gearwheel with teeth projecting parallel to the wheel's axis. The slipping of a belt or rope is a common phenomenon, in the transmission of motion or power between two shafts. The effect of slipping is to reduce the velocity ratio of the system. In precision machines, in which a define velocity ratio is of importance, the only positive drive is by means of gear or toothed wheels. A gear drive is also provided, when the distance between the drive and the follower is very small. A friction wheel with the teeth cut on it is known as toothed wheel or gear.

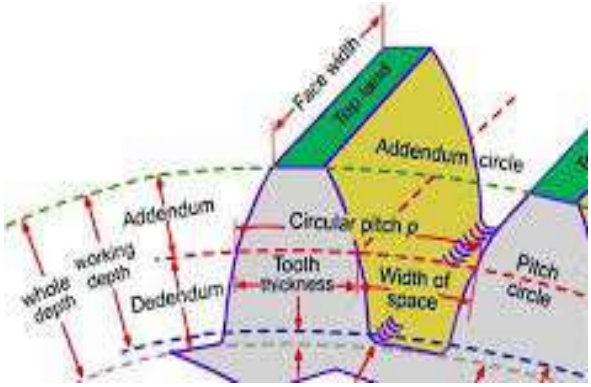

Fig: Terms Used In Gears

2D Drawings of Pipe Bending Machine Components

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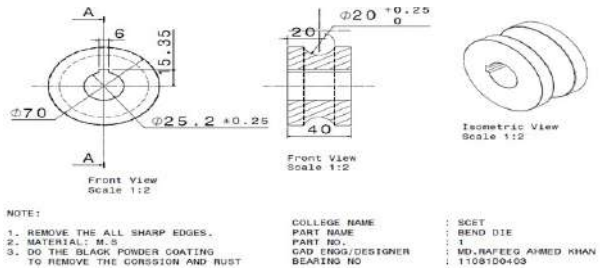

Fig: Bend Die-2D

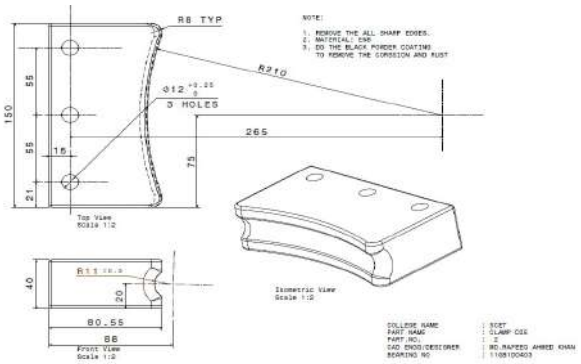

Fig: Clamp Die-2D

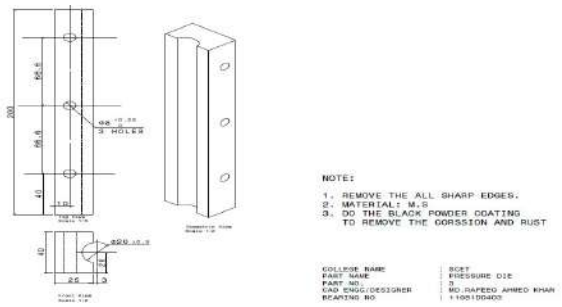

Fig: Pressure Die-2D

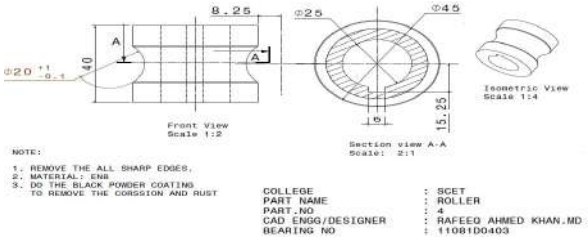

Fig: Roller-2D

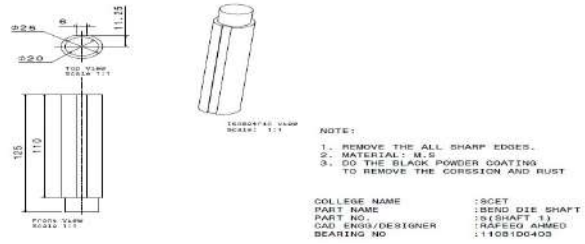

Fig: Bend Die Shaft-2D

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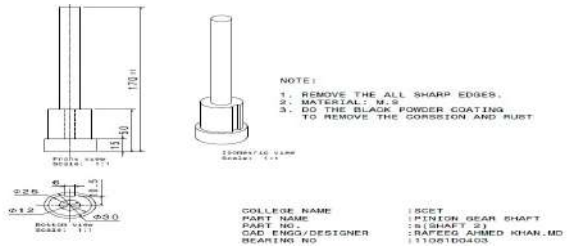

Fig: Pinion Gear Shaft-2D

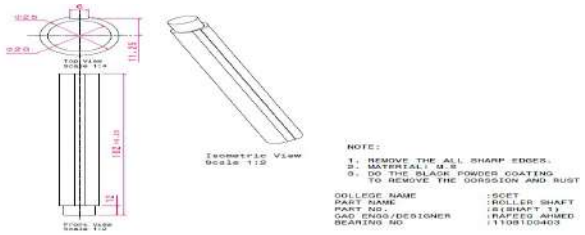

Fig: Roller Shaft-2D

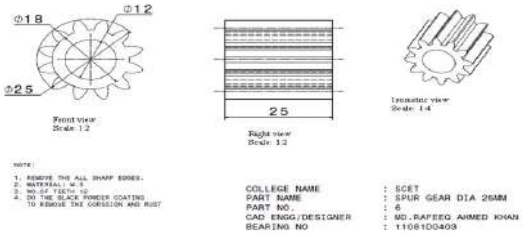

Fig: Spur Gear Diameter 25mm-2D

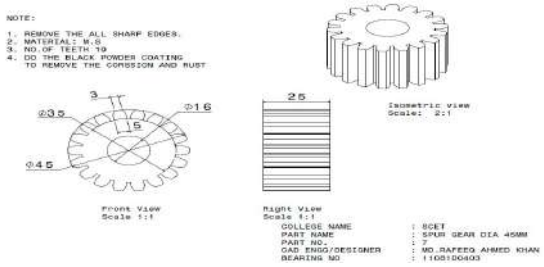

Fig: Spur Gear Diameter 45mm-2D

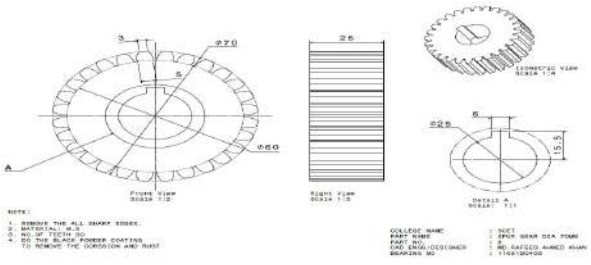

Fig: Spur Gear Diameter 70mm-2D

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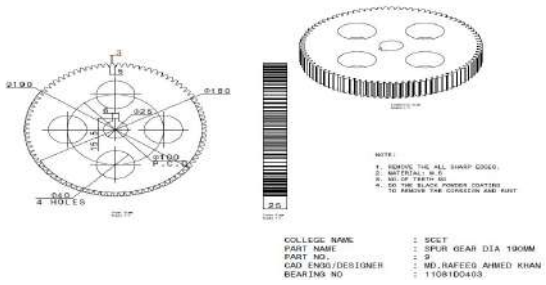

Fig: Spur Gear Diameter 190mm-2D

IV - 3D-MODELING IN CATIA-V5 SOFTWARE

CATIA can be applied to a wide variety of industries, from aerospace and defense, automotive, and industrial equipment, to high tech, shipbuilding, consumer goods, plant design, consumer packaged goods, life sciences, architecture and construction, process power and petroleum, and services. CATIA V4, CATIA V5, Pro/ENGINEER, NX (formerly Unigraphics), and Solid Works are the dominant systems.

Pipe / Tube Bending Machinery Parts ISO-View Images

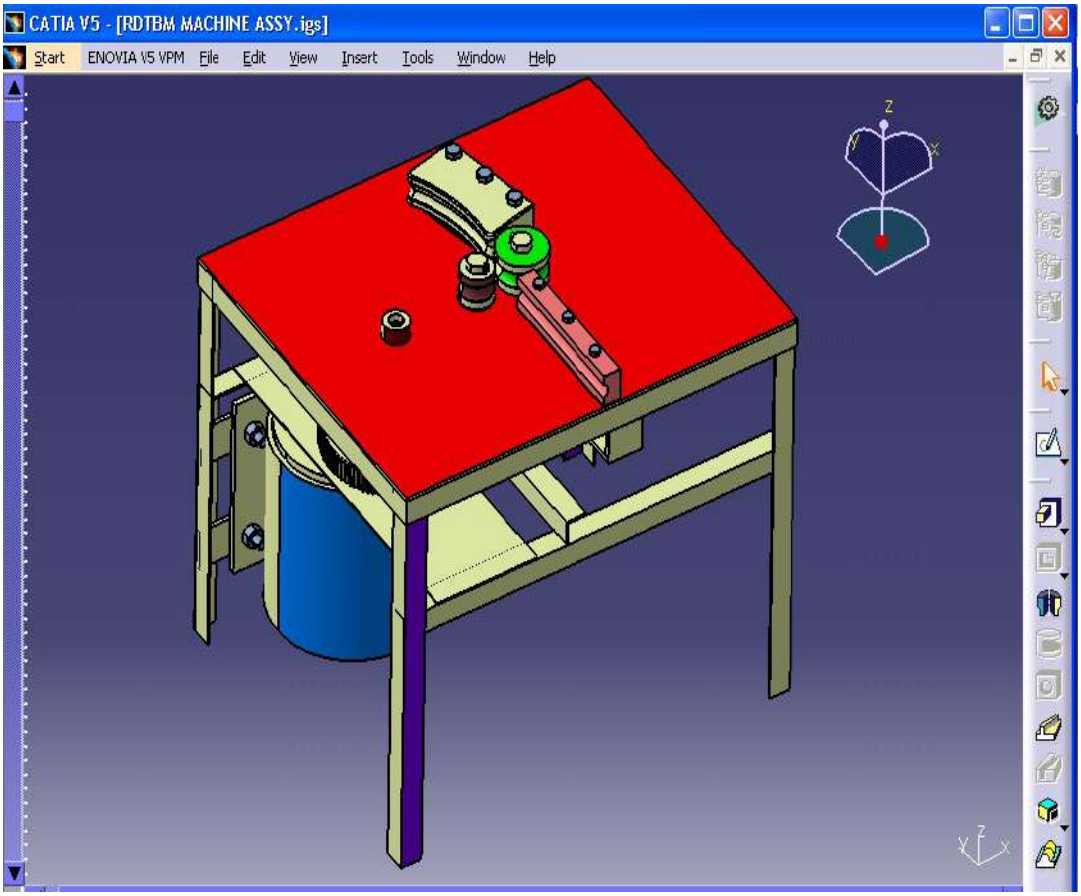

Fig: ISO View of Pipe Bending Machine

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Materials Properties

Material	Density (kg/m3)	Young's modulus (MPa)	Poisson's ratio
Mild steel	7860	2.1e5	0.27

V - ANALYSIS IN ANSYS SOFTWARE

Procedure for FE Analysis Using ANSYS:

The analysis of the Gear Teeth, roller, bend die, pressure die, clamp die & shafts are done using ANSYS.

For compete assembly is not required, motor and attached gear system is to carried out by applying moments at the rotation location along which axis we need to mention. Fixing location is bottom legs of rod assembly machine.

Preprocessor

In this stage the following steps were executed:

Import file in ANSYS window

File Menu > Import> STEP > Click ok for the popped up dialog box > Click

Browse" and choose the file saved from CATIAV5R20 > Click ok to import the file

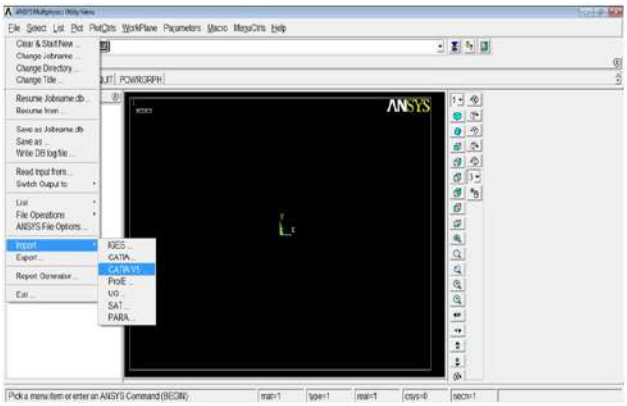

Fig: Import panel in Ansys.

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VI - DISCUSSION ON ANALYSYS RESULT

Results of Displacement Analysis:

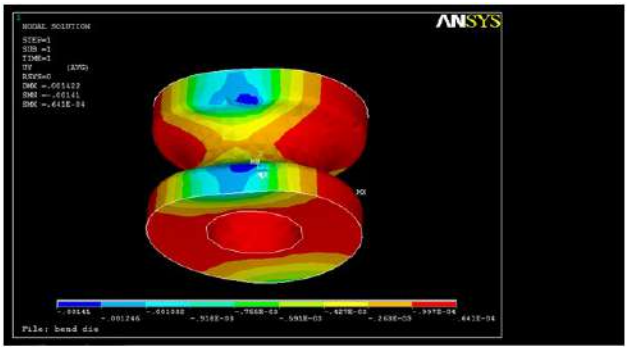

Fig: Displacement of Bend Die

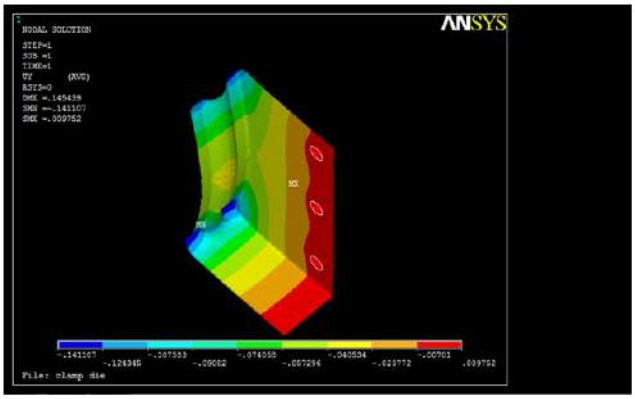

Fig: Displacement of Clamp Die

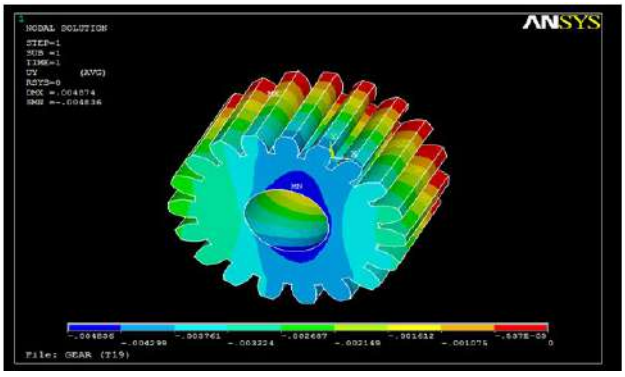

Fig: Displacement of Gear T19

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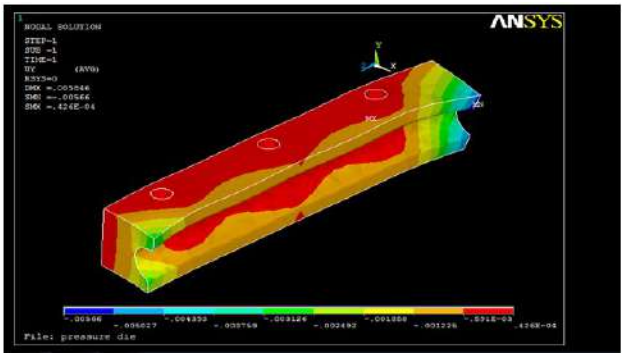

Fig: Displacement of pressure die

Results of Stress analysis:

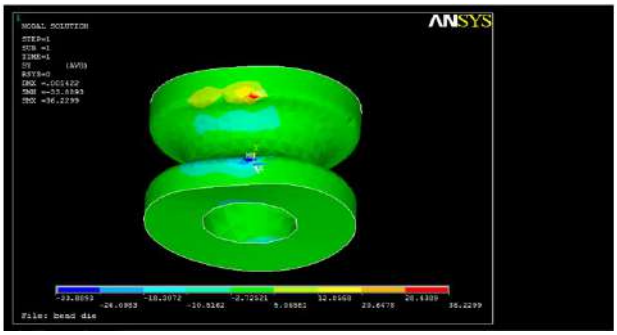

Fig: Stress Analysis of bend die

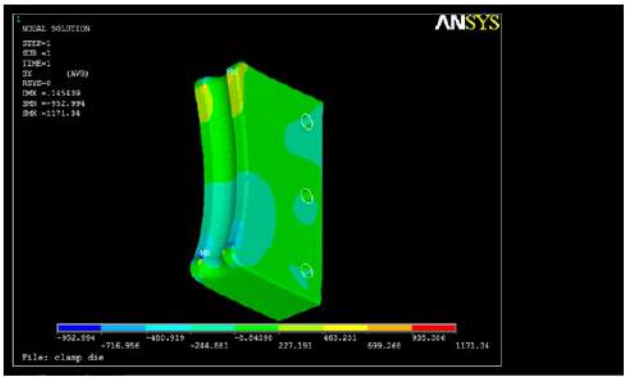

Fig: Stress Analysis of clamp die

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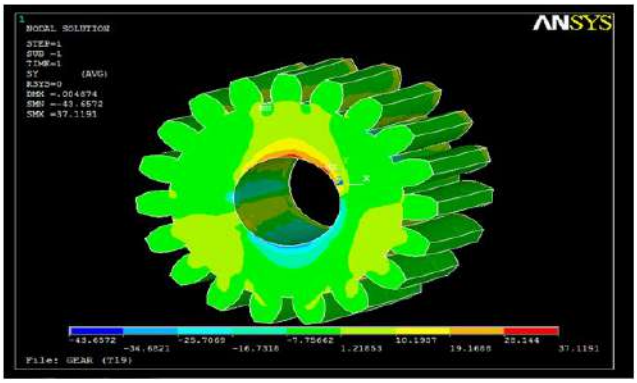

Fig: Stress Analysis of gear t 19

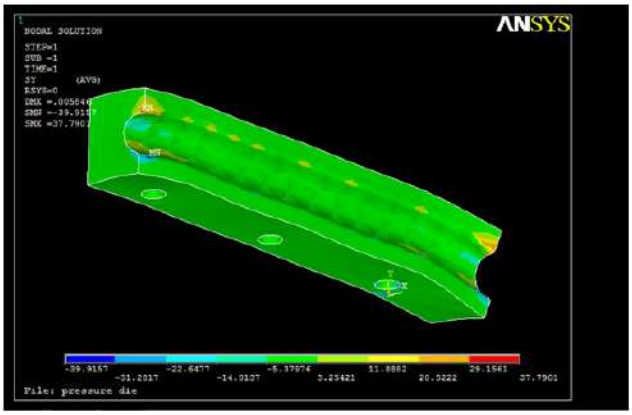

Fig Stress Analysis of pressure die

Results of Strain analysis:

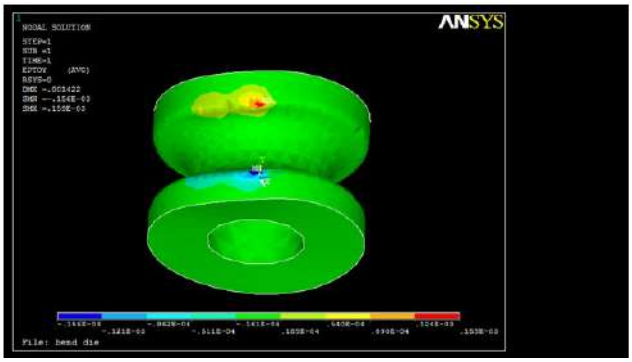

Fig: Strain Analysis of bend die

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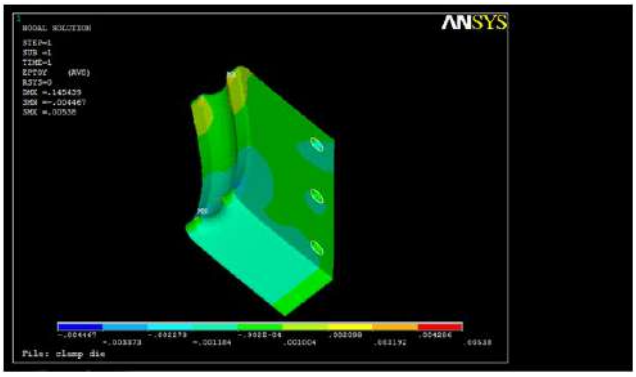

Fig: Strain Analysis of clamp die

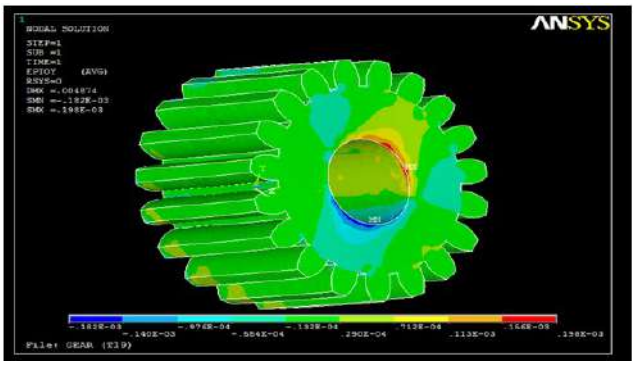

Fig: Strain Analysis of gear t 19

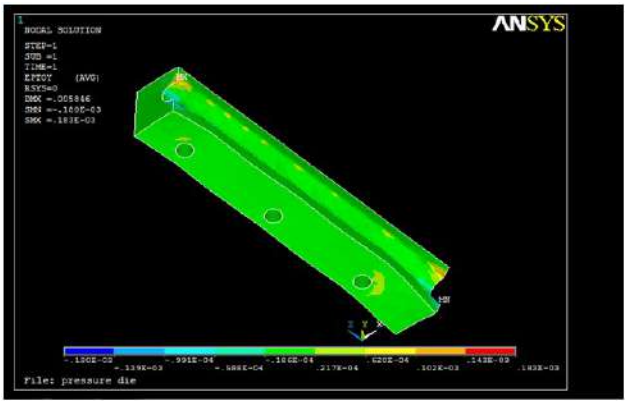

Fig: Strain Analysis of pressure die

VII - CONCLUSION

As per the methodology and analysis results from static analysis the displacements, strain and stress is minimum that means these values are in limit. Analysis results shown that the designs are not having maximum deflection while in the moment of gear mechanism.

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Analysis is consider for pipe pressure has been taken and analyzed on clamp die and pressure die the results which is shown is very less. That's why original equipment is working while pipe bending. The results are shown in less value which is under the yield value of the material.

Displacement, strain and stress values which we got in the above analysis, all are in the limits that means displacement is not more and stress is in limit.

Table: Structural Analysis Results

S.NO	DESCRIPTION	CLAMP DIE	PRESSURE DIE
01	MAX. DISPLACEMENT (IN MM)	0.009752	0.426E-04
02	MAX. STRESS (IN MPA)	1171.34	37.7901
03	MAX. STRAIN	0.00538	0.183E-03

Finally will report that designed assembly is fine and safe, and finite element model results shown same results. There is no failure in analysis.

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