IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 5, May 2021

DOI: 10.17148/IARJSET.2021.8504

STRUCTURAL ANALYSIS OF DRILL BIT HAVING DIFFERENT MATERIAL USING ANSYS

Ashok Kumar Madan*[1] Anshuman Pandey[2], Anirudh Singh Chauhan[3], Ankur Chauhan[4]

Professor, Mechanical Department, Delhi Technological University[1]

UG Students Mechanical Department, Delhi Technological University[2,3,4]

Abstract: Drilling as we all know is a vital part in manufacturing all machines be that a simple hanging bar to one of the most complex rockets. Quite possibly the most important parts of drilling are a drill bit. So, it is vital to strengthen this important aspect to ready it for any use. Our fundamental objective behind this paper is to study the drill bit in detail while doing analysis using ANSYS and testing various materials with different moments and on different work pieces. We will likewise concentrate some of the unconventional types of drilling which paves the way for future of drilling for example, high energy plasma drilling. Our main spotlight will be on deformation and stress analysis using titanium drill bit on Al 1100–O and later we will analyze many more materials such as structured steel and high strength steel. The significance of this analysis becomes more important as it reduces various expenses and labor effort.

Keywords: Manufacturing; Drill bit; Titanium, structured steel, HSS Drill Bit; Ansys

INTRODUCTION

A drill is a device that is used to make round holes and fastening action of the workpiece which is prepared with a cutting tool connection or the usage of apparatus connection, for the most element an uneventful tool or riding force bit, carried out for drilling openings in distinct materials or affixing particular substances together with using clasp. The connection is held by means of the usage of a toss in the route of one facet of the drill and pivoted while squeezed toward the objective fabric. The tip, and a portion of the time edges, of the reducing device takes each basic advance of reducing into the goal material. This could most likely reduce off slender shavings (bend drills or wood screw bits), granulating off little particles (oil boring), pounding and evacuating bits of the workpiece (SDS stone artwork drill), countersinking, counterboring, or specific sports. Drills are regularly implemented in carpentry, metalworking, improvement and do-it-without everyone else's assist ventures. Extraordinarily planned drills are similarly applied in remedy, area missions and unique packages. Drills are accessible with a huge assortment of execution characteristics, for example, electricity and limit.

DIFFERENT PARTS OF DRILLING MACHINE

Base: The base is comprised of Cast Iron which has the capacity of high compressive strength, good wear resistance, and good absorbing capability (i.e., absorb the vibrations induced during working condition) and for these reasons, it goes about as a base to the drilling machine.

Vertical Column: It is exactly positioned at the center of the base which can act as a support for rotating the Swivel table and holding the power transmission framework.

Swivel Table: It is joined to the column which can hold the machine vice in the grips and therefore, the workpiece is fixed in the machine vice to carry out the drilling operation. The Swivel table can move vertically due to rotational motion and can be locked to the column by using locking nut.

Power Transmission System: The system consists of motor, stepped pulley, V-belt, and the Spindle. This system is explained in depth in the working of the drill in the forth coming paras.

Drill Feed Handle: By the rotation of hand-wheel, the spindle moves up and down in the vertical direction in order to give an important measure of feed to the work. Here, the rotational motion is converted into linear motion by implies of a Rack and Pinion mechanism which was explained below.

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 5, May 2021

DOI: 10.17148/IARJSET.2021.8504

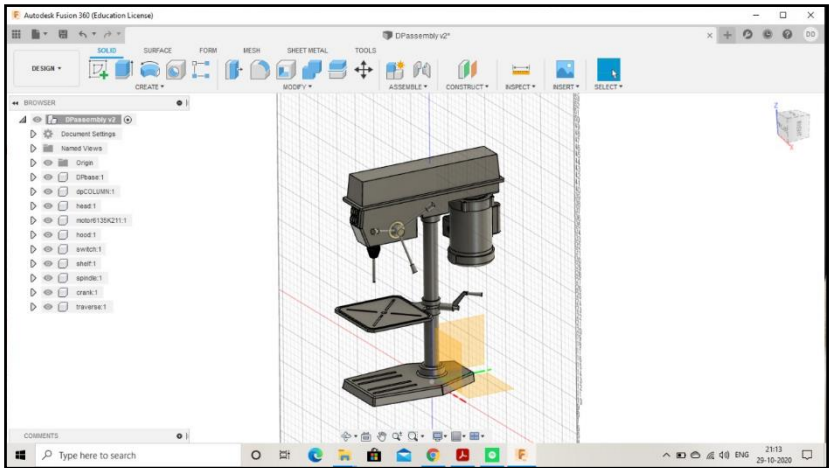


Fig1:model of drill press(fusion360)

Chuck: It is utilized to hold the workpiece. For most part, 3 jaw chuck is utilized for holding circular components and 4 jaw chuck is utilized for holding rectangular components.

Table Clamp: It is utilized to lock the swivel table at the desired location.

Spindle: It is utilized to hold the drill bit along with jaws.

Drill bit: It is the significant part of this machine and is utilized to remove the material in the form of holes from the surface of the workpiece.

DRILL BIT

Boring equipment are slicing gadgets utilized to make spherical and hole gaps, quite often of roundabout cross- location. Boring apparatus are available in several sizes and highlight several employments. Bits are usually connected with a tool, often fundamentally implied to as a drill, which turns them and gives torque and hub power to make the gap. The shank is the piece of the dull equipment gotten a take care of on with the guide of the toss of a drill. The front strains of the dull apparatus are towards one side, and the shank is at the other. Boring apparatus are available popular sizes, portrayed inside the bore sizes article.

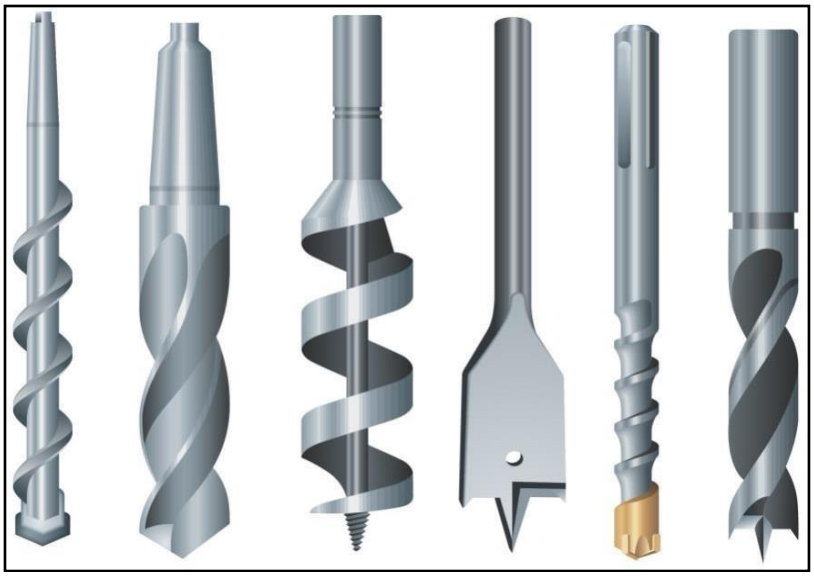


Fig2- different types of drill bit

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 5, May 2021

DOI: 10.17148/IARJSET.2021.8504

WORKING PRINCIPLE OF DRILL MACHINE

When the power is delivered to the motor, the spindle rotates, and thereafter the stepped pulley attached to it also starts to rotate. On the opposite end, one more stepped pulley is appended and that is inverted to increase or decrease the speed of the rotational motion.

Now, a V-belt is set in between the stepped pulleys so as to drive the power transmission. Here a V belt is utilized rather than a flat belt, in order to increase the power effectiveness.

Now the drill bit also rotates which was positioned in the chuck and which was in connection with the spindle. As the Pulleys starts to rotate, the spindle also starts rotating which can rotate/move the drill bit.

Thereafter, by the rotation of hand-wheel, the spindle moves up and down in the vertical direction in order to give the true measure of feed to the work and this drill bit is utilized to make the holes on the component/work piece.

Drill is fitted with a bit, a drill or driver, depending on application requirment, which is secured by a chuck. In some powered drills hammer function is also utilized. Drills vary mainly in speed, power and size to suit different applications . The rotating edge of the drill exerts a large force on small area of contact on the workpiece thus the hole is produced. The removal of metal in a drilling operation is by ways of shearing and extrusion.

ANSYS SIMULATION

In this simulation we will show stress analysis and total displacement analysis of a 6mm drill bit made up of structured steel under the moment of 100N.mm along z axis.

1) Modeling and Meshing: The sketching and modeling of the drill bit is done using SolidWorks software. It is quite possible the most user-friendly software for 3d modeling. Then the model is exported to ANSYS workbench for analysis. The drill bit is given the material as structured steel and the mesh size is given as 1 mm. The model is shown in fig 3 and the mesh element is shown in fig 4.

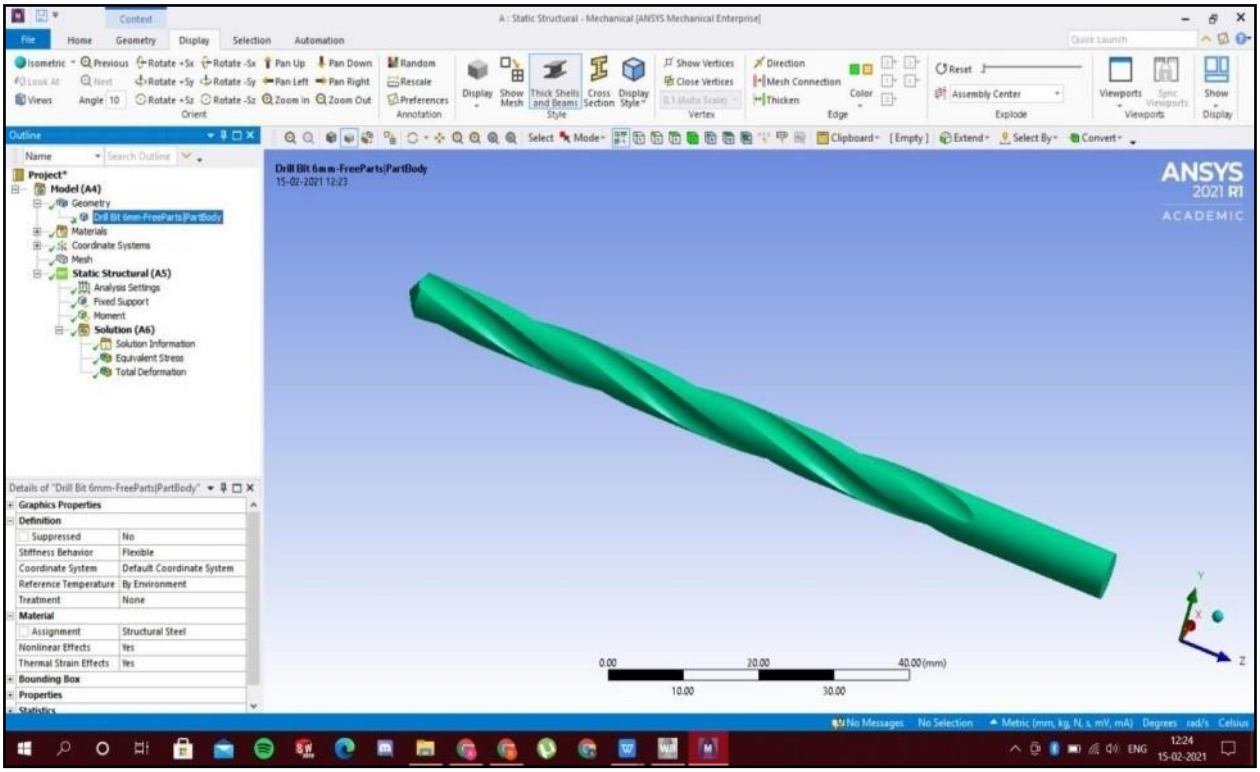


Fig3- Model of drill bit imported from solidworks

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 5, May 2021

DOI: 10.17148/IARJSET.2021.8504

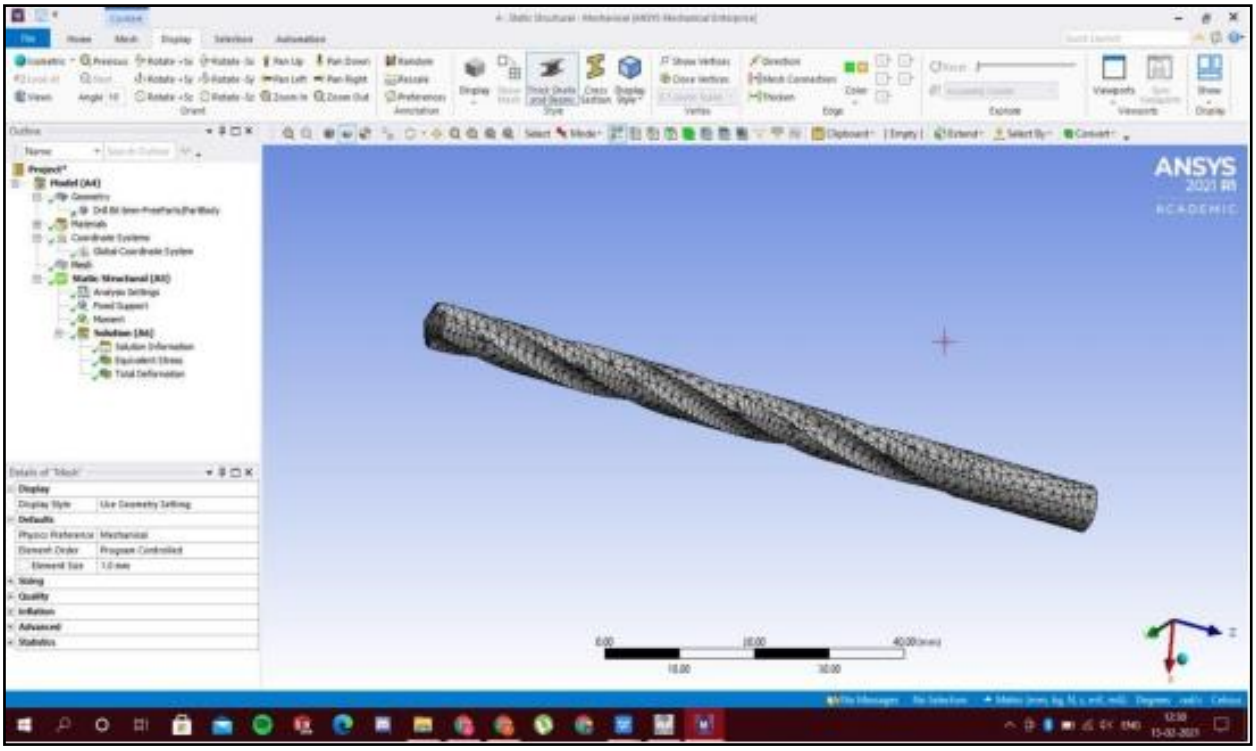


FIG 4:mesh view for analysis

Now to start the analysis we will first give some static structural conditions and restrictions

1) Initially, we will fix one end of the drill so that some kind of stress can be developed in the drill bit.

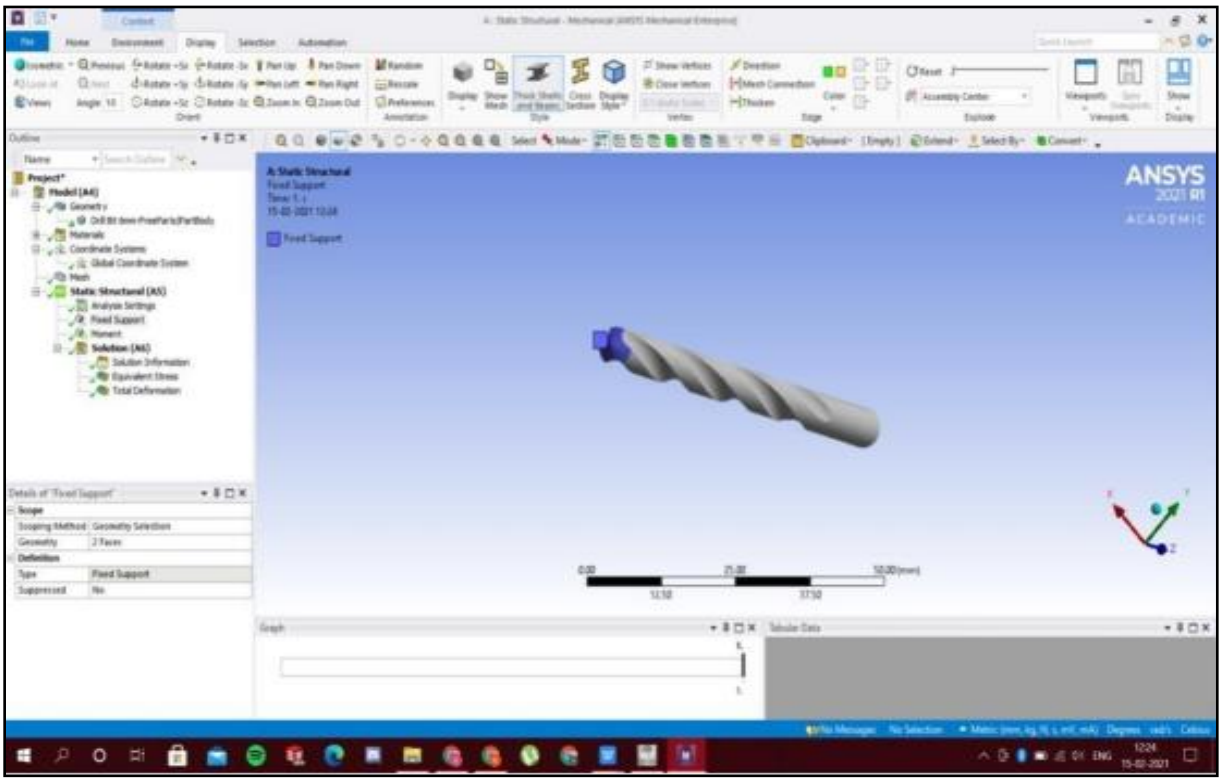


Fig 5-one end fix of drill bit

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 5, May 2021

DOI: 10.17148/IARJSET.2021.8504

2) Now for the second part we will give some moment along the z axis to so that there can also be some kind of deformation.

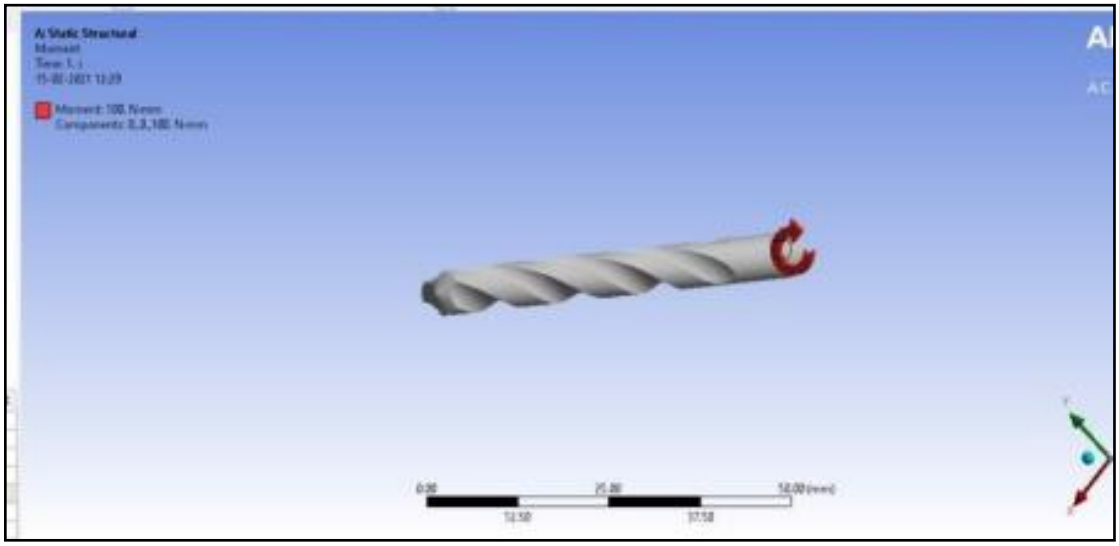


Fig 6- given the moment along z axis(other side)

3) Now we can see in the figure below the distribution of stress in the drill and the max and min stress. By this method we can find the safety limits of a particular material at particular moment.

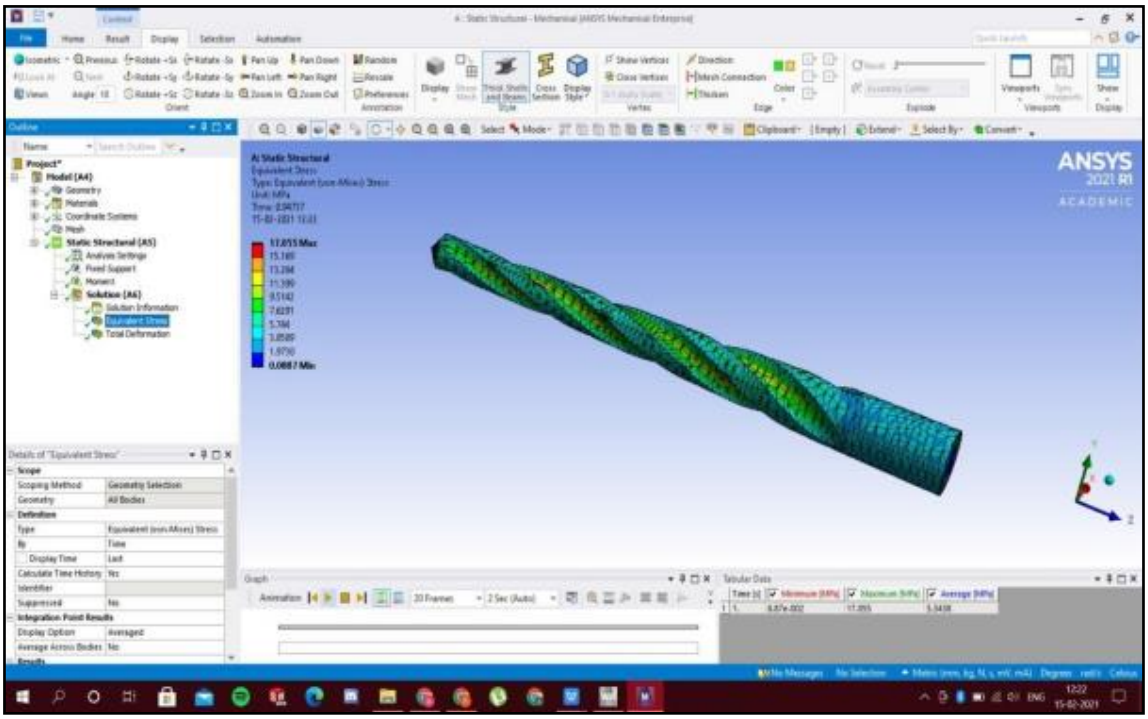


Fig7 : max and min stress distribution on bit

4) In this figure we will look at the deformation of the **titanium alloy** drill bit.

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 5, May 2021

DOI: 10.17148/IARJSET.2021.8504

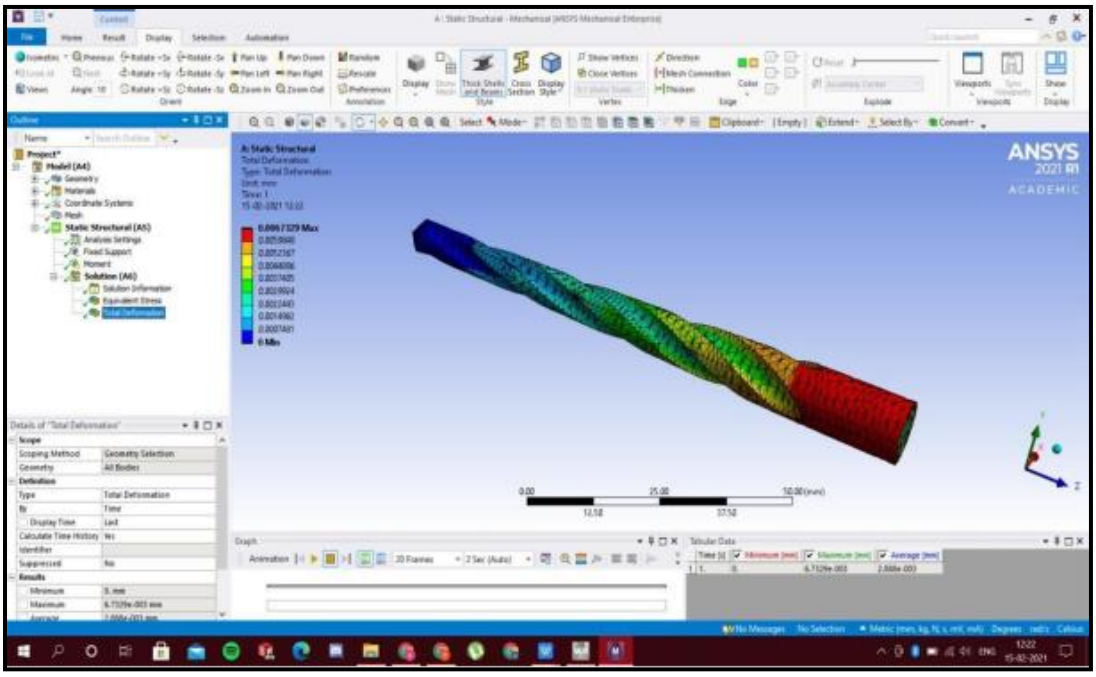


Fig 8- deformation in titanium allow drill bit

5) In this figure we will look at the deformation of the **structured steel** drill bit.

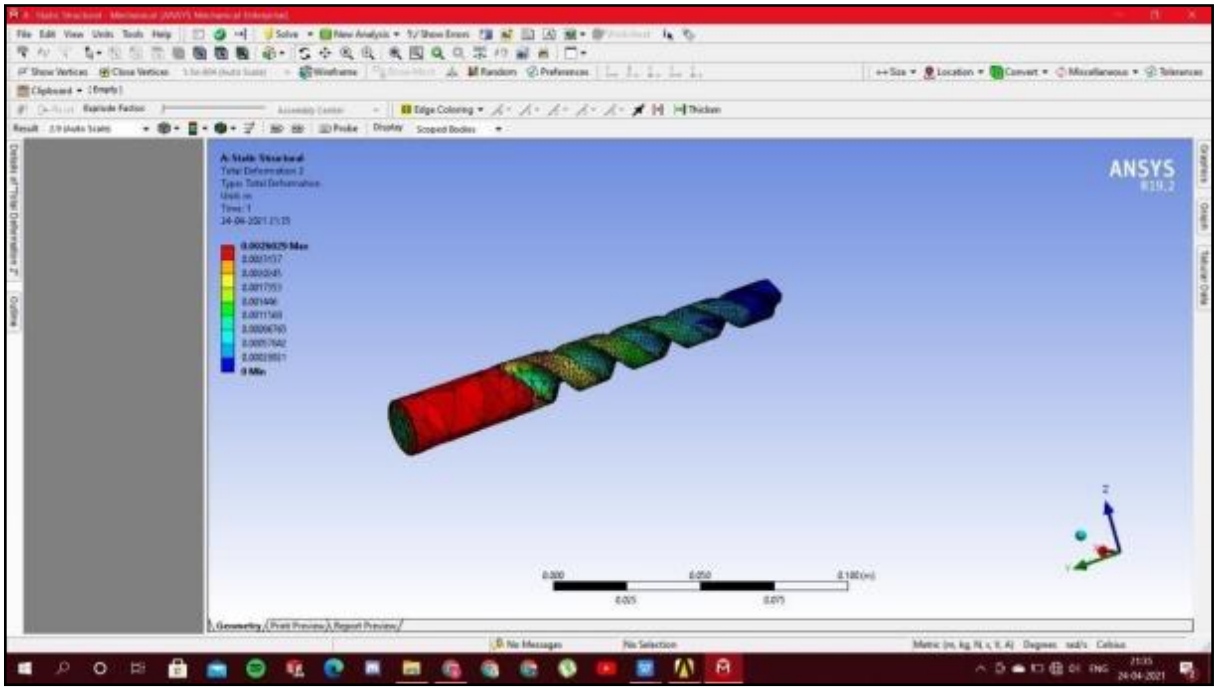


Fig9- deformation on structured steel drill bit

6) In this figure we will look at the deformation of the **HSS (high strength steel)** drill bit.

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 5, May 2021

DOI: 10.17148/IARJSET.2021.8504

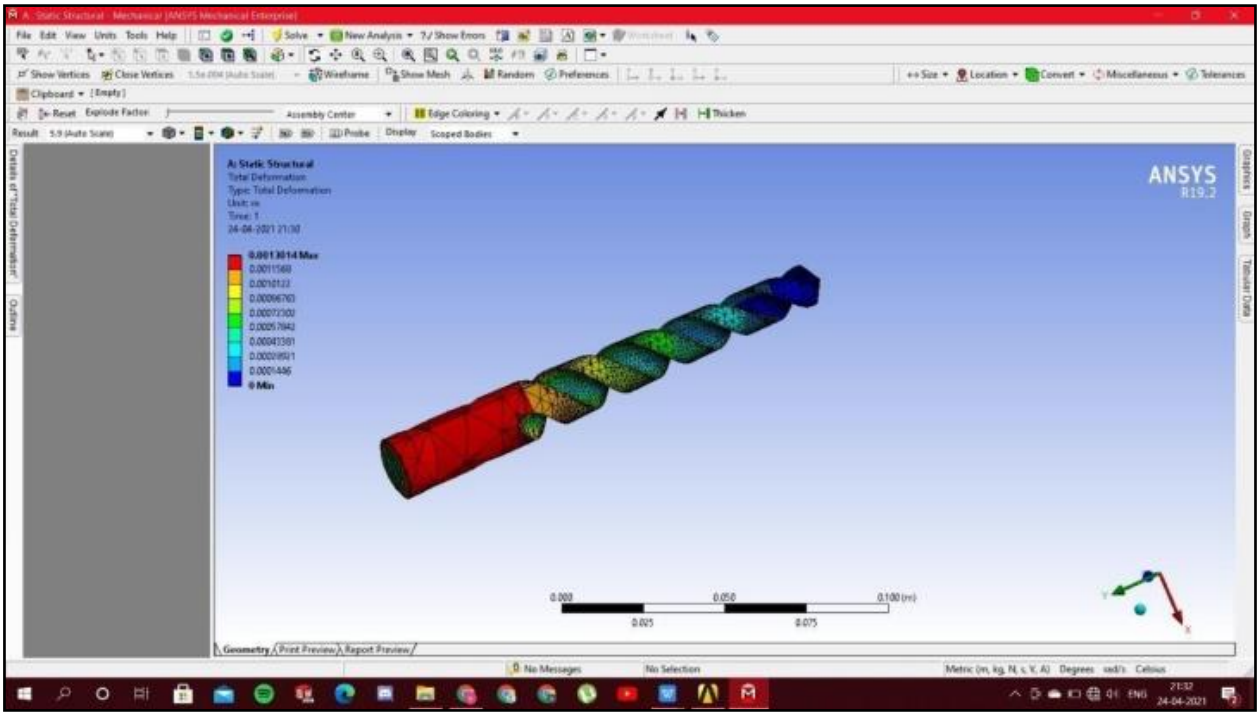


Fig 10- deformation on high strength steel drill bit

For our second analysis we have taken the same drill bit but this time we will present the drilling process of a rectangular box

1) We will start my making our 3D model of the 6 mm drill bit and a box of dimensions 15X50X20 mm^3.We will select the material of drill bit as titanium and that of the piece as Oxygen based Aluminum 1100.

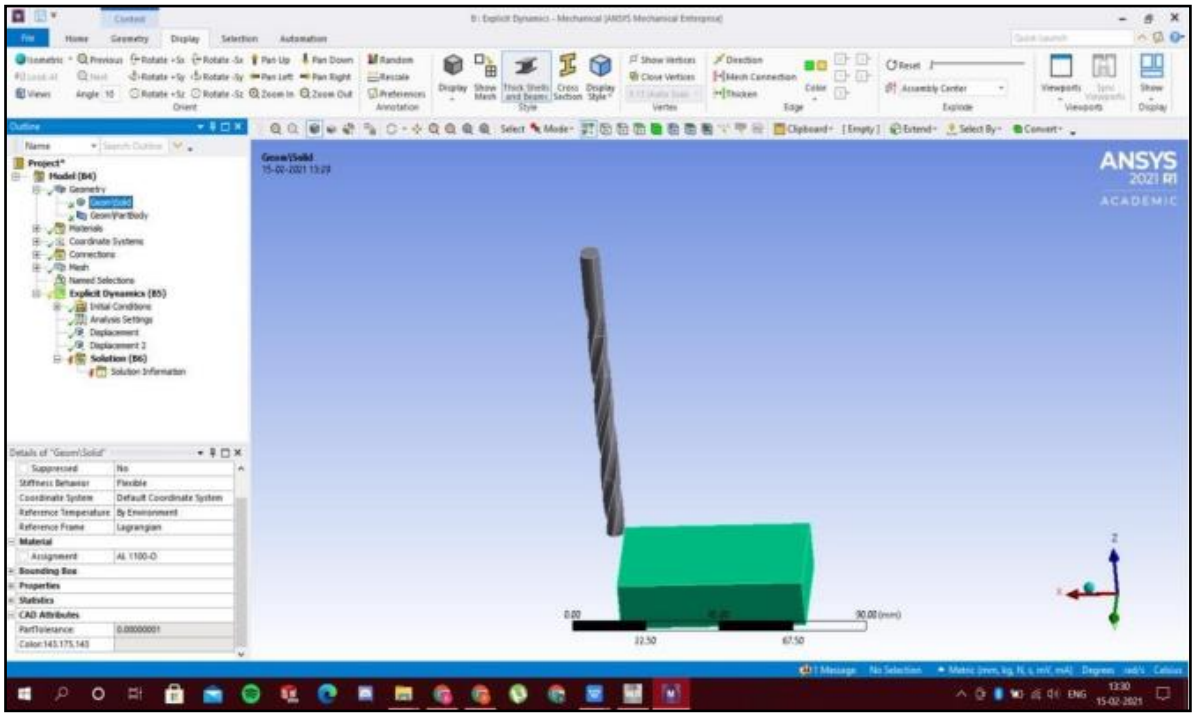


Fig 11- 3D model of block and drill bit

IARJSET

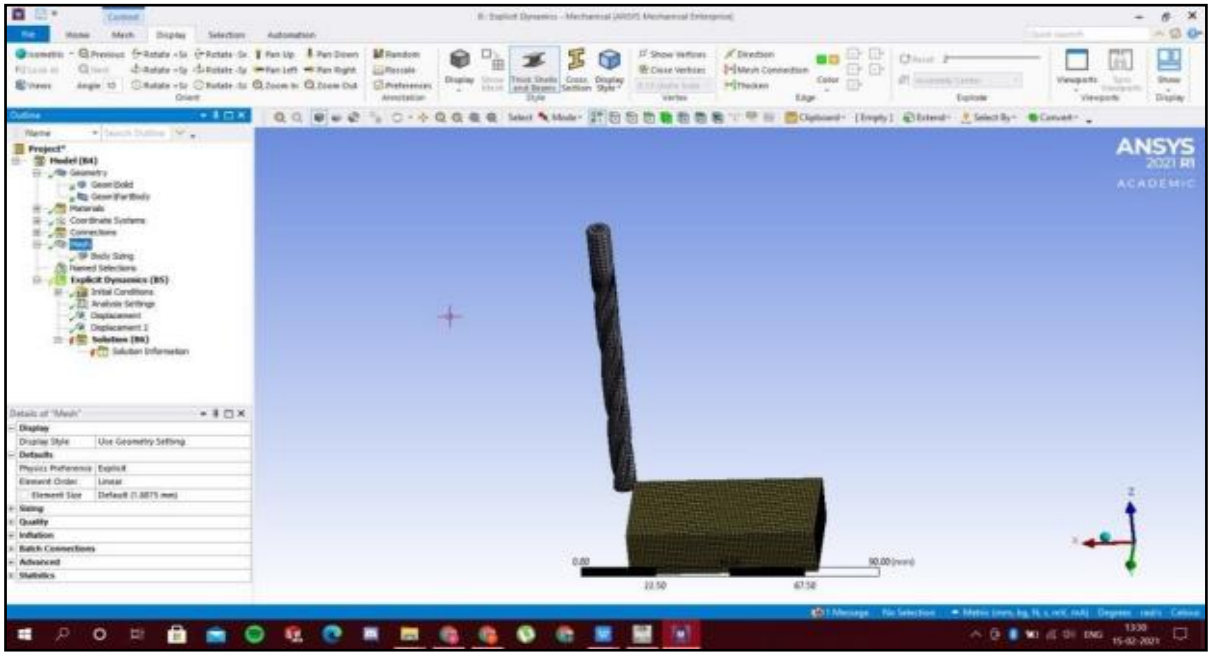
ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 5, May 2021

DOI: 10.17148/IARJSET.2021.8504

2) Now we will make the mesh but this time we will give different mesh sizes to drill (**1.85 mm)** and the work piece**(1mm).**



Now as we have to show the drilling process, we have to give the explicit dynamics to the model. To render the project faster we will reduce time to 0.001 s.

3) Now we will give each body its own cartesian coordinates with a goal that they can move independently. We will give the drill rotational motion along y axis and the translational motion to the work piece in –ve X axis.

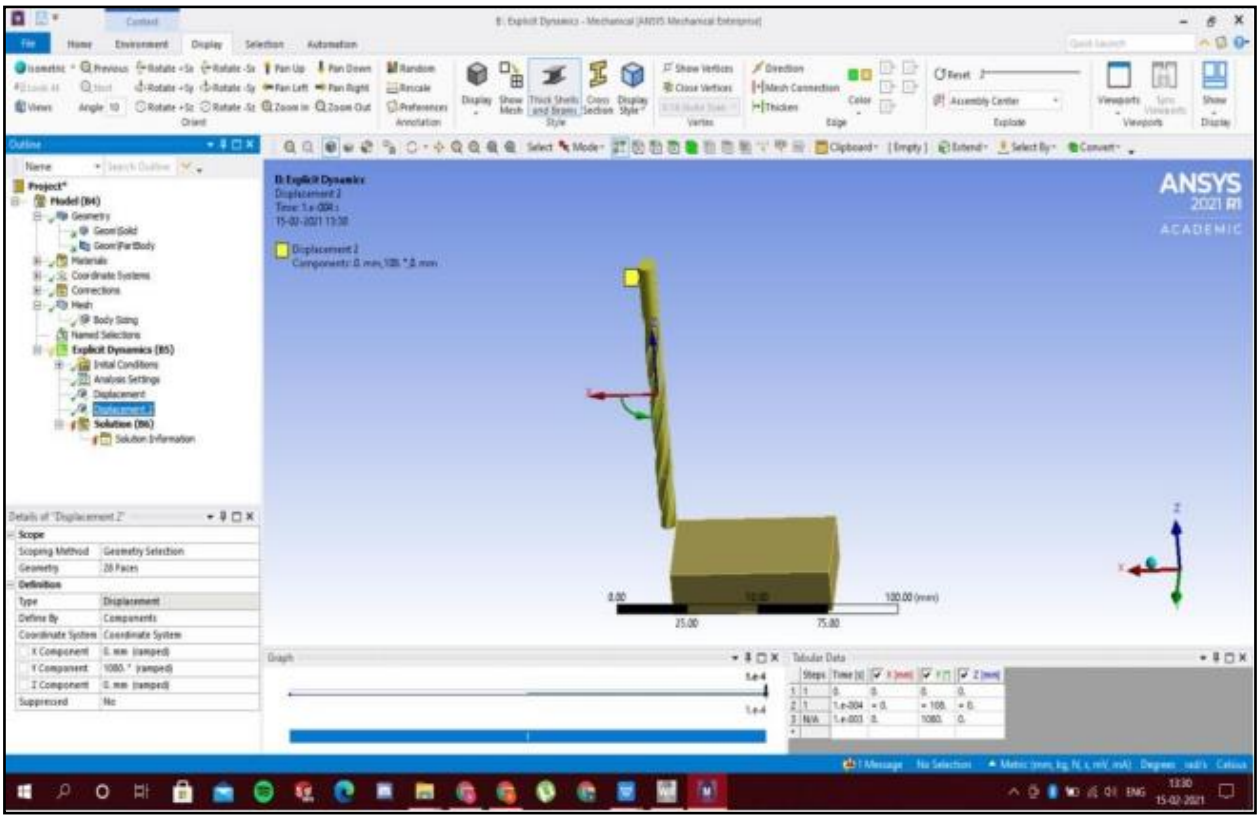


Fig13-drill and block motions

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 5, May 2021

DOI: 10.17148/IARJSET.2021.8504

4) Now that all necessary conditions have been covered, we will begin the analysis by showing total deformation first.

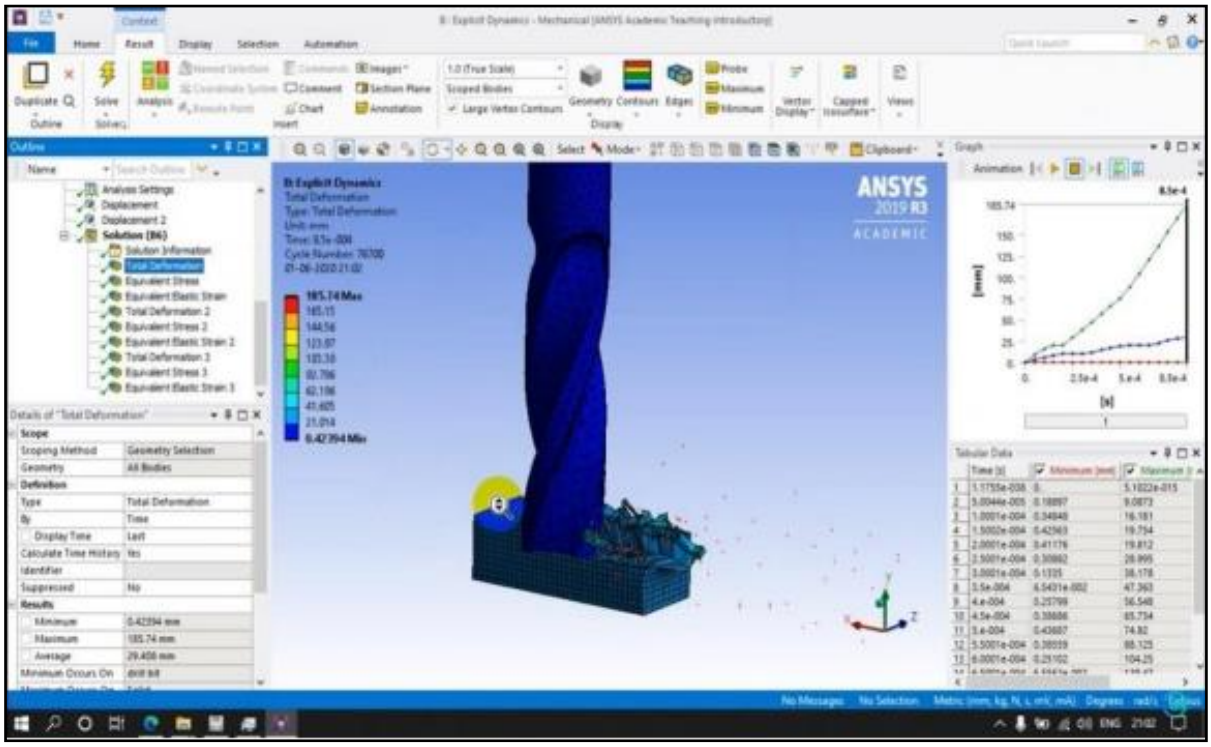


Fig 14-total deformation

5) Now we will show the equivalent stress distribution in MPa and its range.

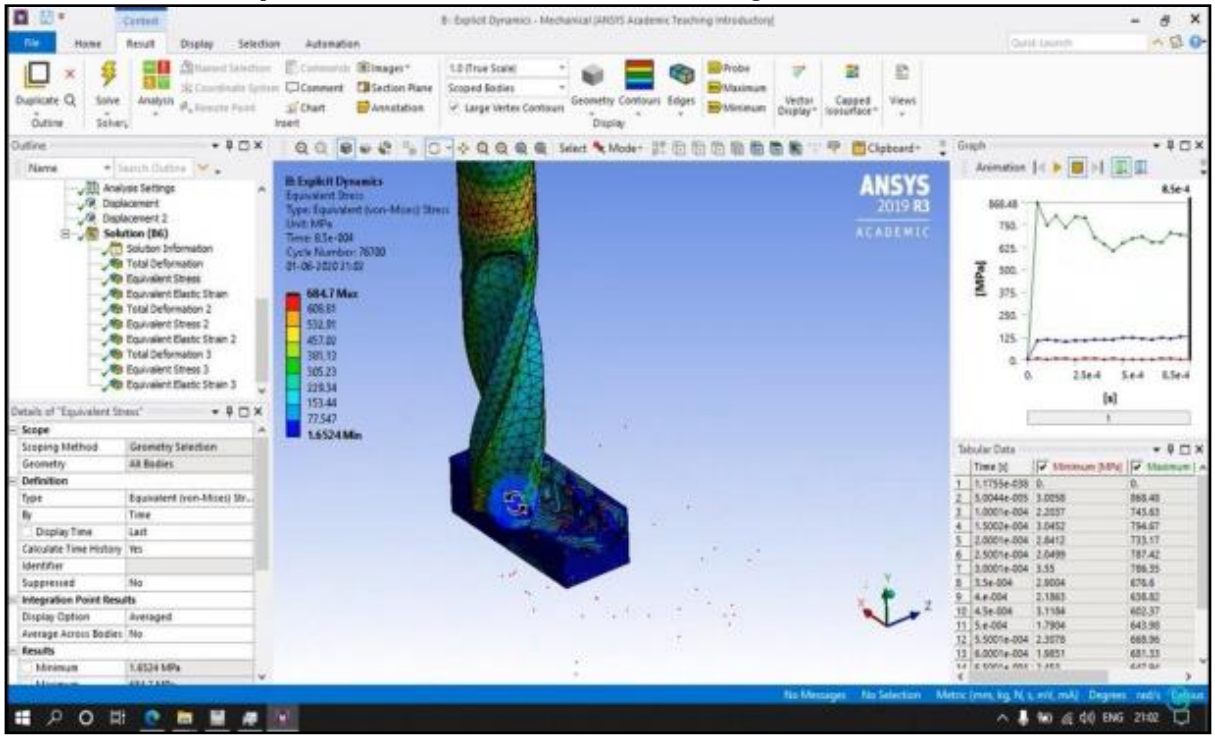


Fig 15-equivalent stress distribution.

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 5, May 2021

DOI: 10.17148/IARJSET.2021.8504

6) Now we will have a look at the equivalent elastic strain developed and a graph showing its value over time. The unit will be mm/mm.

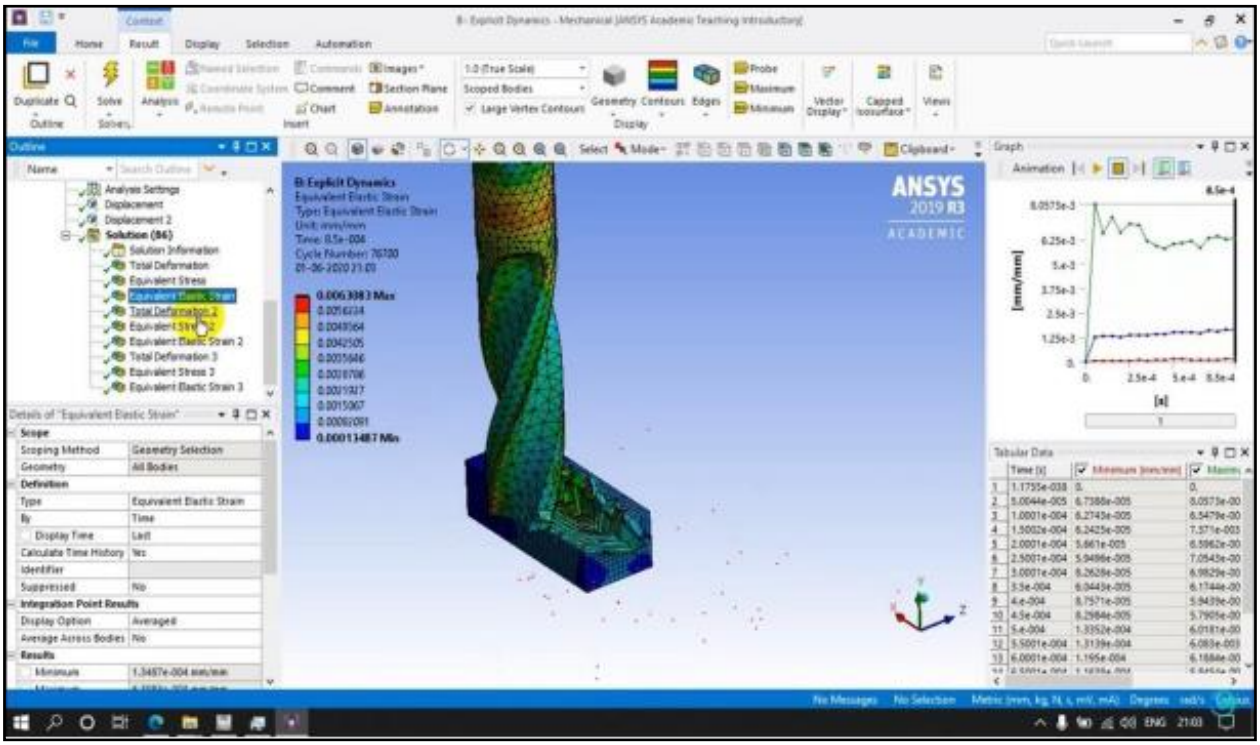


Fig16- elastic strain as it moves

FAILURE TESTING METHODS

Scanning Electron Microscopy: A scanning electron microscope (SEM) QUANTA 250 is used to notice cracks and fracture wall on the drill bit using a voltage of 15- 20 kV. In order to reach outcomes, crack initiation and propagation path are considered or studied.

Optical Microscopy: A KEYENCE 2000 microscope is to notice metallographic structures of the substrate, the carburized layer and the surface around the main crack. Samples are etched for 10 seconds using 4% HNO3 + alcohol solution before the observation. In the light of the outcome, microstructural differences between the qualified and the unqualified were discussed.

Tensile Test: A Letry WDML-3 testing machine is utilized to test tensile properties of the drill bit body. Tests are done in accordance with GB 228-87 standard. In the light of the outcomes, differences of tensile properties between the qualified and the unqualified are discussed.

Charpy Impact Test: A WANCE PIT pendulum impact testing machine is utilized to test impact absorbed energy of the drill bit body. The tests are carried out in accordance with GB/T229-2007 standard.

Rockwell Hardness Test: A JINSHI HR-150 Rockwell hardometer is utilized to test the hardness distribution from the surface to the internal along the radial direction. In the lights of outcomes, homogeneity and quenching degree along the radial direction of drill bit body are studied.

Hydrogen Content Measurement: To measure hydrogen content Infrared absorption method is applied in the drill bits. Samples are taken from the surface layer near the cracks.

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 5, May 2021

DOI: 10.17148/IARJSET.2021.8504

NEW DRILLING TECHNOLOGIES

Hydrothermal spallation – In Thermal spallation drilling a large downhole burner, similar to jet engine is used to apply a high heat flux to the rock face. This drilling technology depends on thermal characters of rock spallation and fusion.

Chemical plasma – this aproach is based on the principle of crushing by high-speed combustion, but here nitric acid is used as oxidizing agent in place of oxygen.

Erosion – in this water jet is used on rock cutting. Different modified variants are available, e.g., use of cavitation, turbulent processes of fluid, combination with mechanical processes, etc.

Laser - During the recent time extraordinary development and research has been made in using high energy laser beams for rock disintegration. This technology was initially develop to be used in military equipment. Now the same technologies is modified to use in different field. In this high Laser energy is used for the thermal spallation, evaporation, melting of rock.

Electric discharge - The strategies utilizing electric discharge depend on long-term experience gained in other application areas.

Electrical plasma – It is relatively new technology used in deep drilling. In this a plasma discharge with high temperature upto 20000°C is used.In long run it may replace the conventional mode.

Direct transfer of heat – in this a rock is electrically melted at about 1400°C. At this temperature lava grabel will float on top, bore hole walls are of glass of surrounding rocks. Cost reduces with depth, with no restriction on depth of bore hole. Bore diameters from 1m to 10m can be performed.

APPLICATIONS

These machines are utilized in industries like manufacturing, metalworking, woodworking, masonry and construction as well. Other than drilling holes, drill machine is featured of performing a variety of tasks like tapping, spot facing, reaming, counter sinking and counter boring etc can be done.

The fundamental function of drill machine is to develop hole of various size in solid work piece. Various drills are utilized for industry particular applications. Drill rigs are utilized to hole or bore water wells and oil wells. Hand drills are utilized for screwing and fastening specially in walls.. Hammer drill is utilized by carpenters to drill and fix the wooden parts.

Cordless drills is used when electric supply is not available for drilling. Pillar drill machine (also referred as drill press) is utilized where it required mass manufacture of drilled materials in a specific selection of size and shape like metal sheets, plastic, wood, glass and physical construction applications. The direction- based power supply is easily controlled in drill press to increase or decrease the drilling speed.

The capability of drill press varies with pillar diameter, spindle nose, spindle travel, spindle speed and electronic motor utilized within machine. These are extensively utilized in automobile, printing and engineering field to increase the tensile power of the machine with efficiently moving out to the resistive materials with quality performance and execution. Milling & drilling machine is widely embraced in the industries where mixing and grinding of solid and liquid substances are required .

Pillar drill machine is utilized to drill holes in concretes, rocks, heavy duty machines, metal sheets, plastic, wood, glass and other material.

CONCLUSION

In the above project we came to know about the drill machine, its working, parts and many more aspects. Then we have discussed various failure testing methods and some of the new drilling technologies.
Later we did the Finite Element Analysis of the drill bit. Our analysis was done on the ANSYS software .
1) At the first place we tried to analyze the stress in the static as well as when the drill bit rotates about Z axis(i.e. in motion).
2) Secondly, we had simulated three types of materials i.e., titanium, structured steel, HSS, in which we found that the drilling was best performed using the titanium alloy drillbit (drill bit angle=118°).

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 5, May 2021

DOI: 10.17148/IARJSET.2021.8504

3) Lastly, we attempted to simulate the situation where the titanium made drill bit penetrates into a rectangular block made of aluminum and found the overall stress distribution (which was max. on the lip of the drill and minimum on the flutes) and the elastic strain graph of the same.

REFERENCES

1)G. Manoj reddy, D. pinakapani reddy, K. jagadeesh, M.eswar sai, Y. V. Hanumantha Rao, "Finite Element Stress Analysis of Drill Bit in Ansys", International Journal of Innovative Technology and Exploring Engineering (IJITEE), Vol. 8 Issue 7, May 2019.
2) Alessandra Caggiano, Luigi Nele and Roberto Teti, "Drilling of Fiber-Reinforced Composite Materials for Aeronautical Assembly Processes"
3) V Srinivas, "Design and Analysis of drill bit with various materials using ANSYS", Journal of Engineering and Applied Sciences, Vol. 13 Issue 6, 2018.
4) Meenakshi Sundaram Nagaraj, Chakaravarthy Ezhilarasan, A. John Presin Kumar and Rishab Betala, "Analysis of Multipoint cutting tool temperature using FEM and CFD", Manufacturing Review 5
5) M S Momeni, S Ridha, S J Hosseini1, B Meyghani and S S Emamian, "Bit selection using field drilling data and mathematical investigation", IOP Conference Series: Materials Science and Engineering, 328, 2018
6) Amardeepak M, Dr. Narayana B Doddapattar, Dr. Sanjeev Murthy, "Effect of Cutting Parameters on Surface Roughness inDrilling andTribological Analysis of Aluminium Alloy Al7068", International Journal of Research and Analytical Reviews (IJRAR), Vol. 5 Issue 4, October 2018.
7) Gautam Shankar Tate, Aamir M. Shaikh, Anant Dattatray Awasare, "Drilling on Glass Fiber Reinforced Composite Material for Enhancement of Drilling Quality: A Review", International Journal of Engineering Research and Technology, Vol. 10 Number 1 2017.
8) Pravin Pawar, Raj Ballav, Amaresh Kumar, "Modeling and Simulation of Drilling Process in Ti-6Al-4V, Al6061 Using Deform-3D Software", International Journal of ChemTech Research, Vol. 10 No.3, pp 137-142, 2017.
9) Puneeth H V, Smitha B S, "Studies on Tool Life and Cutting forces for drilling operation using Uncoated and coated HSS tool", International Research Journal of Engineering and Technology (IRJET), Volume 4 Issue 6, June - 2017.
10) A. Attanasio, F. Fainia, J.C. Outeirob, "FEM simulation of tool wear in drilling", 16th CIRP Conference on Modelling of Machining Operations, ScienceDirect, 2017.
11) C. Thomas Vangsness III, Bruce L. Tai, "A feasibility study of laser-assisted titanium implant drilling for periprosthetic fracture repair", 3rd CIRP Conference on BioManufacturing, ScienceDirect, 2017.
12) Rajan. K, Prabhushankar. N, Nagarajan. N, "A Review of Current Micro Drilling Processes", International Journal of Innovative Science, Engineering & Technology, Vol. 3 Issue 1, January 2016.
13) B. Suresh kumar, V. Vijayan, N. Baskar, "Comparison of coated and uncoated carbide drill bits for drilling titanium grade 2 material", MECHANIKA. Vol. 22(6): 571 – 575, 2016.
14) JialinTian, ChuanhongFu, LinYang, ZhiYang, XiaolinPang, YouLi, YonghaoZhu, and GangLiu, "The Wear Analysis Model of Drill Bit Cutting Element with Torsion Vibration", Advances in Mechanical Engineering, 01 July 2016