

EXPERIMENTAL INVESTIGATION OF CUTTING TOOL USING CNC MILLING MACHINE

Submitted in partial fulfilment of the requirements for the award of
Bachelor of Engineering Degree in Mechanical Engineering.

By

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**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of DINESH K (38150703) and LOGESWAR RS (38150061), who carried out the project work as a team who carried out the project entitled **“EXPERIMENTAL INVESTIGATION OF CUTTING TOOL USING CNC MILLING MACHINE”** under our supervision from September 2021 to May 2022.

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DECLARATION

We, **DINESH K (38150703)** and **LOGESWAR RS (38150061)** hereby declare that the project Report entitled “**EXPERIMENTAL INVESTIGATION OF CUTTING TOOL USING CNC MILLING MACHINE**” done by us under the guidance of **Dr. R.B.DURAIRAJ, M.Tech., Ph.D., SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, CHENNAI** is submitted in partial Fulfilment of the requirements for the award of Bachelor of Engineering degree in Mechanical Engineering.

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ABSTRACT

The project aims at impact of reducing forces at the drill bit and end mill cutter tool in manufacturing. For High-speed machining operation, accuracy of device tip of the tool locations an essential function in mass manufacturing. In order to get excessive precision, excessive-performance automated production the device existence need to be longer sufficient to resist diverse stresses performing on it. The goal is to expand the mixture of most efficient reducing parameters the use of Taguchi method at the side of that we additionally going to investigate the surface finish of the workpiece.

In this project Taguchi technique has been hired with Orthogonal Array for 3 parameters particularly speed, Feed and Depth of cut. For every of those parameters 3 various levels have to be diagnosed and used to carry out the reducing parameters for minimizing the stresses performing on diverse device in CNC milling. The materials decided on for aluminium plate with drill bit and end mill cutter. By applying different cutting force on Cutting tools various stress, strain, total deformation that supports software ANSYS. Cutting tools are modelled in CREO software program and then imported in ANSYS software program for evaluation. stress analysis of cutting tool is observed and cutting force is higher compared to thrust force. We carry out the surface end check at the workpiece to behavior the optimum cutting parameters.

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LIST OF SYMBOLS AND ABBEREVIATIONS

SYMBOL	DEFINITION
AJM	Abrasive jet machining
USM	Ultrasonic machining
AWJM	Abrasive water jet machining
WJM	Water jet machining
EDM	Electro discharge machining
HSM	High speed machining
2D	Two dimensions
3D	Three dimensions
CNC	Computer numerical control
NC	Numerical control
FEM	Finite element method
DFA	Deterministic finite automation
MDF	Medium density fiber board
AISI	American iron and steel institute
GFRP	Glass fiber reinforcement plastic
HSS	High speed steel
MRR	Material removal rate
OAL	Overall length
LOC	Length of cut
LBS	Length below shank
VMM	Vertical milling machine
rpm	Revolution per minute

1.INTRODUCTION

1.1 INTRODUCTION TO MACHINING

Machining is production manner that entails putting off substances the use of reducing for casting off the undesirable substances from a few work-piece and changing it into the form you desire. A big piece of inventory is used for reducing the workpiece. The big inventory is probably in any form consisting of strong bar, flat sheet, beam or maybe hole tubes. The manner also can be accomplished on a few present components like forging or casting.

1.2 CLASSIFICATION OF MACHINING

Material removal processes can be split into two types.

1.2.1 UNCONVENTIONAL MACHINING PROCESSES

Non-conventional machines, on the alternative hand, are the one machines that perform routinely with the assist of computer systems and there's no want for human intervention or operator. These are typically managed through an automated robotic or computer system. Example of operations that make use of non-conventional machines are vehicle portray in vehicle production plants, welding vehicle devices and in production techniques in which in there's intense excessive of temperature concerned that human can't withstand.

1.2.2 CONVENTIONAL MACHINING PROCESSES

Conventional machining makes use of tool, including lathes, milling machines, boring machines, drill machines, or other with a point reducing device to get rid of cloth to acquire the favored geometry. Usually there may be a right away contact between the tool and raw material.

1.3 INTRODUCTION TO HIGHSPEED MACHINING

High speed machining (HSM) is a complicated and rising machining method hired universally to system complicated elements with excessive productivity, progressed quality, sustainability and economy.

Initially, HSM changed into advanced to system missile and plane additives made from aluminum and its alloys. Due to non-stop tendencies withinside the discipline of HSM these days to be had system can system difficult metals, tough to reduce materials, complicated 3d geometry and micro/nano functions with excessive accuracy and precision. The reducing velocity variety in HSM relies upon up on numerous parameters consisting of paintings cloth, device cloth, reducing situations and system. However, paintings cloth extensively impacts the reducing velocity.

1.4 COMPONENTS OF A CNC MACHINE

Most milling machines have similar components. First you have the base of the machine. This usually includes the worktable are usually ball screws, to move the machine. It can also include the electric drives that move the various machine components. CNC machines also require what is generally referred to as the "controller", which is the computer part of the CNC. This computer controller uses programmed input values and feedback loop data to control machine motion. In addition, milling machines include any spindle. The spindle rotates cutting tools for milling or, in the case of a lathe, rotates the actual workpiece for lathe tooling.

1.5 CNC MILLING MACHINE

Milling is the system of reducing and drilling material (like wood or metal). A milling system, no matter whether or not it's operated manually or via CNC, makes use of a rotating cylindrical device known as a milling cutter. It is held in a spindle and may range in shape and size. The primary distinction among a milling system and another drilling system is the capacity to reduce in extraordinary angles and circulate alongside extraordinary axes. For this reason, there are numerous sorts of milling machines, which might be particular with the aid of using quantity of motion axes.

1.6 OPTIMIZATION

Optimization problems of sorts stand up in all quantitative disciplines from computer technological knowledge and engineering to operations research and economics, and the development of answer techniques has been of interest in

arithmetic for centuries. In the simplest case, an optimization problem consists of maximizing or minimizing a real function through manner of method of systematically selecting input values from interior an allowed set and computing the value of the feature. More generally, optimization includes finding "extraordinary available" values of some intention function given a defined domain (or input), which incorporates pretty some extraordinary sorts of intention capabilities and extraordinary sorts of domains.

1.7 TOOL DYNAMOMETER

A machine-tool dynamometer is a multi-component dynamometer this is used to degree forces all through using the machine device. Empirical calculations of those forces may be cross-checked and confirmed experimentally the use of those machine tool dynamometers. With advances in technology, machine-tool dynamometers are increasingly used for the correct dimension of forces and for optimizing the machining process. These multi-issue forces are measured as an person issue pressure in every co-ordinate, depending at the coordinate machine used. The forces all through machining are depending on intensity of cut, feed rate, reducing speed, device fabric and geometry, material of the work piece and different elements which include use of lubrication/cooling all through machining.

1.8 CUTTING TOOL

Cutting tool substances have to be more difficult than the material that is to be cut, and the tool have to be capable of face up to the warmth and pressure generated withinside the metal- reducing process. Also, the tool should have a particular geometry, with clearance angles designed in order that the reducing part can touch the workpiece without the rest of the device dragging at the workpiece surface. The angle of the reducing face is likewise important, as is the flute width, quantity of flutes or teeth, and margin size. In order to increase the life, all the procedure need to be performed, and the speeds and feeds at which the tool is run.

1.9 DRILLING TOOL

A drill or drilling system is a tool in the main used for making spherical holes or moving fasteners. The widely used drill bit tools are mentioned below. HSS drill bits specialize in drilling via steel. These drill bits derive their power from a aggregate of vanadium and tungsten content. They normally have a hardness grade of 60 or above at the Rockwell hardness scale. HSS drill bits are usually known as twist bits due to their cylindrical shank and are the go-to drill bit for standard use. They are available sizes starting from 0.8 mm to 12mm, and in addition they drill via wooden and plastic.

2. LITERATURE SURVEY

J.S.Strenkowski et al focused-on development of FEM for oblique cutting by taking forces and moments acting on drill, which was based on visco elastic effects on drill bit geometry for oblique sections. An analytical model for oblique cutting was described to analyze a single section in the cutting lip region of the drill bit.

S.Madhavan et al conducted drilling experiments on GFRP material using taguchi design of experiments, but they concentrated on the effect of delamination factor by varying the cutting speed, feed rate, thrust force and torque during drilling operation.

R.Vimal Sam Singh et al developed a fuzzy logic-based model for forecasting thrust force and torque during drilling, but not considered the changes on geometry of drill.

P.V.Gopal Krishna et al concentrated their experiments on friction drilling which is unconventional drilling process in which a cone type rotating tool penetrate into material and generate a hole, without generating chips. Aluminum (AA6351) is taken as work material and friction drilling is carried out by hss conical rotating tool, finally they developed mathematical models for axial thrust force and torque.

M.Pirtini et al considered principles of mechanics to develop mathematical models in drilling to predict cutting forces and surface finish of a hole. This model is able to simulate the cutting forces for various machining conditions in the process in order to obtain drilled profiles. Therefore, in addition to predict the forces, the new model allows finding and visualization of drilled shapes in 3D.

G.Krishna studied and investigated "Selection of Optimum Process Parameters in High Speed CNC End-Milling of Composite Materials Using Meta Heuristic Techniques.

M.Vijaya Kumaret al, presented in their paper, effect of drilling parameters of AMMC

to minimize the thrust force, temperature and surface finish using DFA method.

Balinder Singh minimized “Optimization of Input Process Parameters in CNC Milling Machine of EN24 Steel”.

G.Petropoulos, I.Ntziantzias, C.Anghel, made observations in “A predictive model of slicing forces in milling the usage of Taguchi & response surface strategies”.

Vaishak N L et al put their efforts to understand the effect of parameters like thrust force and torque that are generated during drilling of granite particulate reinforced epoxy composite. The results said that cutting speed and feed rates are influenced more on induced damage in drilling.

S.Prakash et al conducted experimental study drilling operation towards medium density fiber (MDF) board. They focused on to the study of various drilling parameters such as feed rate, spindle speed, drill diameter and board thickness on the thrust force generated during drilling.

N.Gopikrishna and M.Shiva Chander determined the surface roughness in the paper “Determining the Influence of Cutting Fluid on Surface Roughness during Machining of EN24 and EN8 steel by using CNC Milling Machine”.

M.Sundeep et al investigated experimentally on drilling behavior of AISI 316 and attempt made to optimize the process parameters using Taguchi design of experiments method. The process parameters of spindle speed, feed rate and drill diameter are affected by thrust and torque during drilling operations.

B.Satish Kumar and N.Gopikrishna made an investigation in “optimization of turning process parameters, on EN 9 carbon steel using grey relational analysis”.

3. AIM AND SCOPE OF THE PROJECT

3.1 AIM OF THE PROJECT

For high-speed machining process tool wear plays a main role in order to minimize the tool wear, We perform experimentation and analysis to find out the optimum cutting parameters for that specific tool to minimize the tool wear to increase machining efficiency. The main aim of this experimental investigation of cutting tool having,

- Obtain optimum combination of parameters,
- Minimize the tool wear,
- Maximize the tool life,
- Maximize the MRR.

To increase the life of the cutting tool at the same time maximize the efficiency of the machining process.

3.2 SCOPE OF THE PROJECT

Milling is a process that used to make planar surfaces with quicker material removal and true ground first-rate. The crucial goal of the technology of steel decreasing is the answer of practical problems related to the inexperienced and specific elimination of metals from work piece. It has been recognized that the reliable quantitative predictions of the several technological overall performance measures, ideally withinside the shape of equations, are essential to expand optimization strategies for selecting cutting conditions in method making plans. This experiment carried out to enhance the ground give up nice of aluminum alloy 6061 work piece and HSS tool with the aid of using the usage of Taguchi's technique consisting of L9 orthogonal array. A series of experiments can be achieved with the help of using different milling parameters, spindle speed, feed load and depth of less. Taguchi method is used to take a look at the impact of method parameters and installation correlation some of the reducing speed, feed and depth of reduce with apprehend to the primary machinability component, surface end. Validations of the modeled equations to be proved.

4. MATERIALS AND METHODS

4.1 METHODOLOGY

The project was performed on CNC milling machine with aluminium-6061. The machining is mainly governed by three cutting tool parameters they are speed, feed and depth of cut. We varying the speed, feed and depth of cut to machine the aluminium-6061 to find out the cutting forces acting on the tool using milling tool dynamometer. After experimentation the tools are modeled in CREO software with appropriate dimensions, the modeled tools are imported into ANSYS software to perform the analysis to find the total deformation, stress, strain and strain energy. After the analysis result are tabulated and we found the optimum combination of cutting tool parameters.

4.2 MATERIAL AND PROCESS

Material could need a step with inside the manner of coming up with any physical object. In the content of product design, the principle aim of material choice is to limit value at the same time as assembly product overall performance goals, systematic choice of the pleasant material for a given utility starts with properties and charges of candidate materials.

SPECIMEN MATERIAL: Aluminium-6061.

TOOL MATERIAL: M08 molybdenum high speed steel drill bit and M10 molybdenum high speed steel end mill cutter.

DEVICE: Tool dynamometer to calculate the cutting force.

SOFTWARE USED: Cero and Ansys.

4.3 PROCESS PARAMETER

For this process we select speed, feed, depth of cut as cutting tool parameters.

4.3.1 DRILL BIT PARAMETERS

Process Parameters	Level 1	Level 2	Level 3
Speed (rpm)	600	1200	1800
Feed (mm/min)	80	120	160
Depth of Cut (mm)	3	6	9

Table 4.1 Drill Bit Parameters

4.3.2 END MILL CUTTER PARAMETERS

Process Parameters	Level 1	Level 2	Level 3
Speed (rpm)	600	1200	1800
Feed (mm/min)	80	120	160
Depth of Cut (mm)	1	2	3

Table 4.2 End Mill Cutter Parameters

4.4 DESIGN OF EXPERIMENTS

For listed input parameters experiments are planned by following Taguchi technique and L9 Orthogonal array was performed.

4.5 EXPERIMENT PROCESS PARAMETERS

To design the experiment and cutting tool parameters are varied in order to obtain the L9 Orthogonal array was tabulated below. By providing various speed, feed and depth of cut to all the levels to identify the efficiency.

4.5.1 LEVEL OF EXPERIMENT FOR DRILLING

Levels	Speed (rpm)	Feed (mm/min)	Depth of Cut (mm)
L1	600	80	3
L2	600	120	6
L3	600	160	9
L4	1200	80	6
L5	1200	120	9
L6	1200	160	3
L7	1800	80	9
L8	1800	120	3
L9	1800	160	6

Table 4.3 Level of Experiment for Drilling

4.5.2 LEVEL OF EXPERIMENT FOR END MILL CUTTER

Levels	Speed (rpm)	Feed (mm/min)	Depth of Cut (mm)
L1	600	80	1
L2	600	120	2
L3	600	160	3
L4	1200	80	2
L5	1200	120	3
L6	1200	160	1
L7	1800	80	3
L8	1800	120	1
L9	1800	160	2

Table 4.4 Level of Experiment for End Mill Cutter

4.6 EXPERIMENTAL SETUP

After each experiment force is calculated with the help of tool dynamometer and the setup is shown figure 4.2



Fig 4.1 CNC MILLING MACHINE



Fig 4.2 EXPERIMENTAL SETUP

4.7 EXPERIMENTATION RESULT

The experiment was performed on various level of cutting parameters and cutting forces are estimated and results are tabulated below.

Moment Calculation

Moment = Thrust force $\times$ Radial distance of drill bit Moment

eg: $157 \times 4 = 628 \text{ N.mm}$

4.7.1 EXPERIMENTATION RESULT FOR M08 DRILL BIT

Levels	Speed (rpm)	Feed (mm/min)	Depth of Cut (mm)	Thrust Force (N)	Moment (N.mm)
L1	600	80	3	157	628
L2	600	120	6	173	692
L3	600	160	9	185	740
L4	1200	80	6	134	536
L5	1200	120	9	147	588
L6	1200	160	3	157	628
L7	1800	80	9	121	484
L8	1800	120	3	134	536
L9	1800	160	6	143	572

Table 4.5 Experimentation result for M08 drill bit

4.7.2 EXPERIMENTATION RESULT FOR M10 END MILL CUTTER

Levels	Speed (rpm)	Feed (mm/min)	Depth of Cut (mm)	Thrust Force (N)	Moment (N.mm)
L1	600	80	1	26.1522	130.761
L2	600	120	2	78.3000	391.5
L3	600	160	3	156.6783	783.3915
L4	1200	80	2	26.1522	130.761
L5	1200	120	3	58.725	293.625
L6	1200	160	1	26.1522	130.761
L7	1800	80	3	26.0739	130.3695
L8	1800	120	1	8.7696	43.848
L9	1800	160	2	34.9218	174.609

Table 4.6 Experimentation Result for M10 End Mill Cutter

4.8 MODELLING

A representation of a real objects or system of objects for purpose of visualizing its appearance or analysing its behaviour.

4.8.1 TWO AND THREE- DIMENSIONAL DRAWING

A 2D drawing states that sits in only the X and Y axis. More simply, A 2D drawing is flat and has a width and length but no depth or thickness. A drawing is a 2D model of 3D space if you want it to be. The two-dimensional model of three-dimensional space is where the edges of the page are parallel to two of the three dimensions and the third dimension is depicted through overlapping, diminishing size and other techniques called the perspective.

4.8.2 DESIGN TOOLS

The tool which are used to create the geometrical model in a designing software are known as design tools. CAD, or computer-aided design and drafting (CADD), is the use of computer technology for design and design documentation. CAD software replaces manual drafting with an automated process.

4.8.3 CREO

Creo is a family or suite of Computer-aided design (CAD) apps supporting product design for discrete manufacturers and is developed by PTC.

4.8.3.1 3D COMMANDS USED IN CREO

S.NO	COMMAND	FUNCTION
1	EXTRUDE	Extrusion is a process used to create volume of a fixed cross-sectional area. Extrude tool to create a solid or surface and to add or remove material.
2	REVOLVE	It is a method of defining three-dimensional geometry by revolving a sketched section around a centerline. Revolve tool to create a solid or surface feature and to add or remove material.

Tab 4.7 3D Commands used in CREO

4.8.3.2 2D COMMANDS USED IN CREO

S.NO	COMMAND	FUNCTION
1	LINE	It can be used for making simple lines in the drawing.
2	CIRCLE	It is the command used for making a circle.
3	RECTANGLE	This command will make a rectangle
4	TRIMING	This command is used for trimming a geometry.
5	FILLET	This can be used to add rounded corners to sharp edges are called as fillets.

Tab 4.8 2D commands used in CREO

4.8.3 M08 HSS DRILL BIT TWO-DIMENSIONAL VIEW

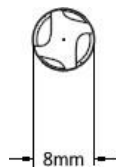


Fig 4.3.1 a) Front view

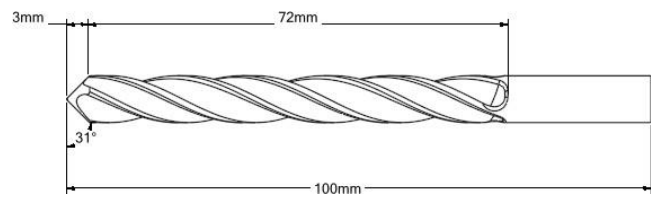


Fig 4.3.2 b) Side view

4.8.4 M10 HSS END MILL CUTTER TWO-DIMENSIONAL VIEW

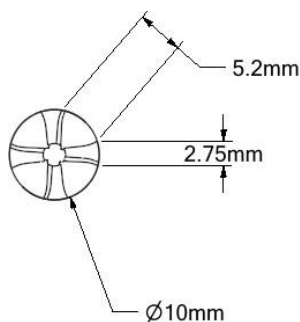


Fig 4.4.1 a) Front view

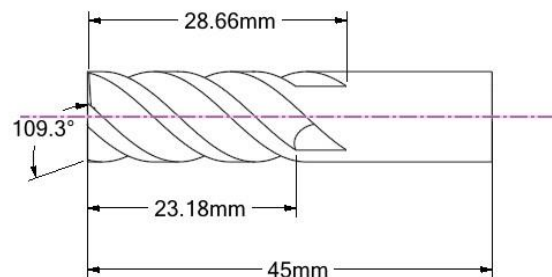


Fig 4.4.2 b) Side view

4.8.5 M08 HSS DRILL BIT 3-DIMENSIONAL VIEW

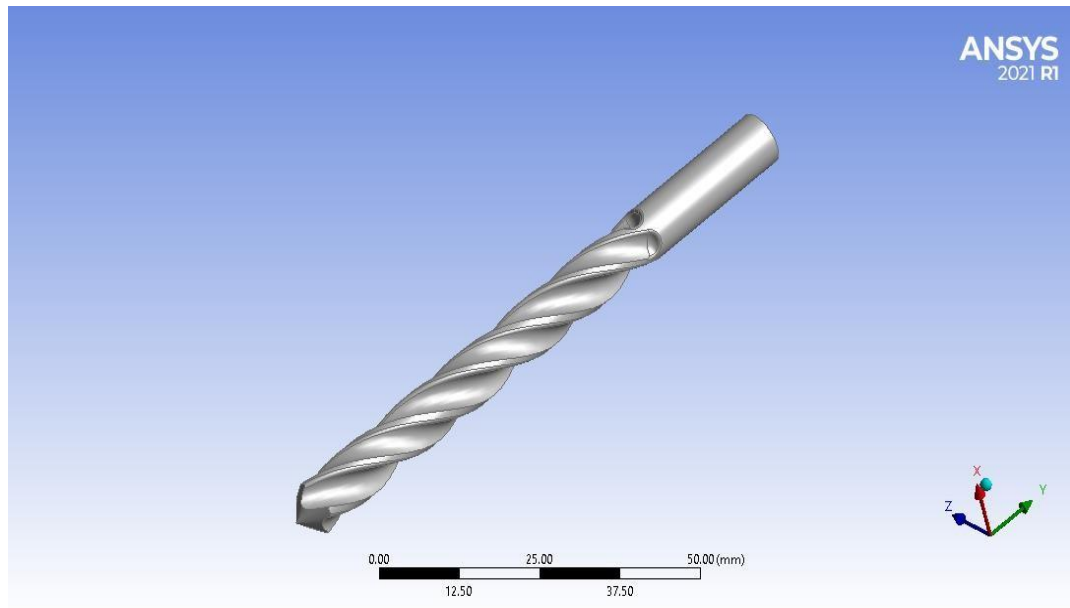


Fig 4.3.3 c) Isometric view

All Dimensions are in mm

4.8.6 M10 HSS END MILL CUTTER 3-DIMENSIONAL VIEW

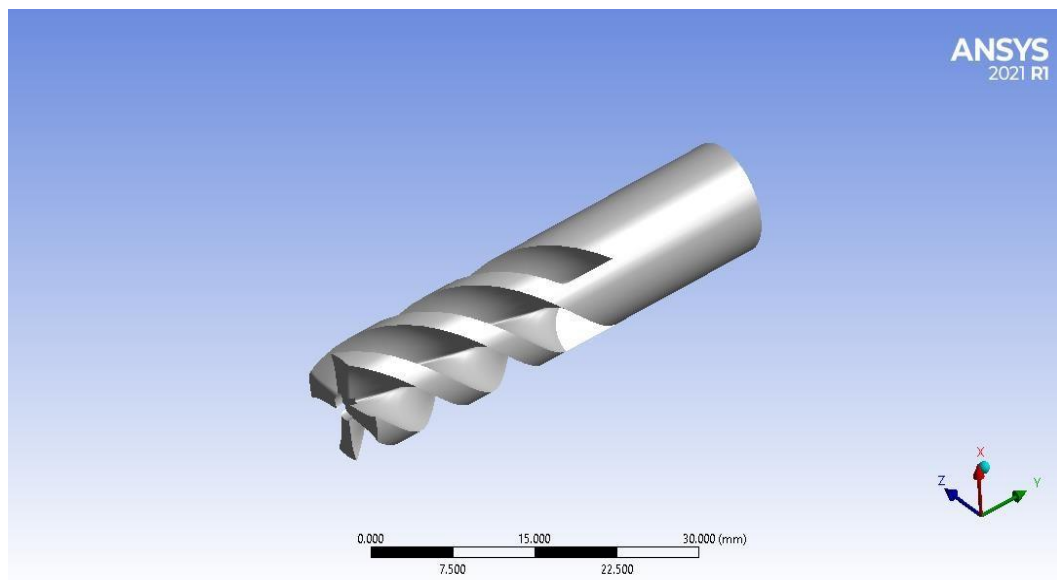


Fig 4.4.3 c) Isometric view

All Dimensions are in mm

4.9 ANALYSIS

Analysis is a process of evaluating the performance. There is various analysis process are available in market. We are select Static Structural analysis to evaluate the performance.

4.9.1 STRUCTURAL ANALYSIS

Structural Analysis evaluation is the dedication of the outcomes of masses on bodily systems and their components. Structures problem to this sort of evaluation consist of all that should resist masses, including buildings, bridges, vehicles, furniture, attire, soil strata, prostheses and organic tissue.

4.9.2 STRESS ANALYSIS

Stress analysis Is a modern-day term used to give an explanation for analyses in which the outcomes quantities include stresses and strains. Stress is described because the pressure throughout a "small" boundary in step with unit area. Strain is geometrical degree of deformation representing the relative displacement among particles.

4.9.3 ANALYSIS TOOL

Ansys is select as an analysis tool evaluate the performance. ANSYS 2021 R1 version is choose to analysis. Ansys Inc. Is an American public agency primarily based totally in Canonsburg, Pennsylvania. It develops and markets engineering simulation software program. Ansys software program is used to layout merchandise and semiconductors, in addition to create simulations that take a look at a product's durability, temperature distribution, fluid movements, and electromagnetic properties

4.9.4 GEOMETRY IMPORTING

Geometry Importing Geometry is modelled in CREO 4.0.by the appropriate dimension of our tools and then geometry is imported to ANSYS 2021 R1 design modular geometry. Following the Geometry of drill bit and end mill cutter are imported intoa design modeler of ANSYS 2021 R1.

4.9.4 Importing M08 HSS Drill Bit

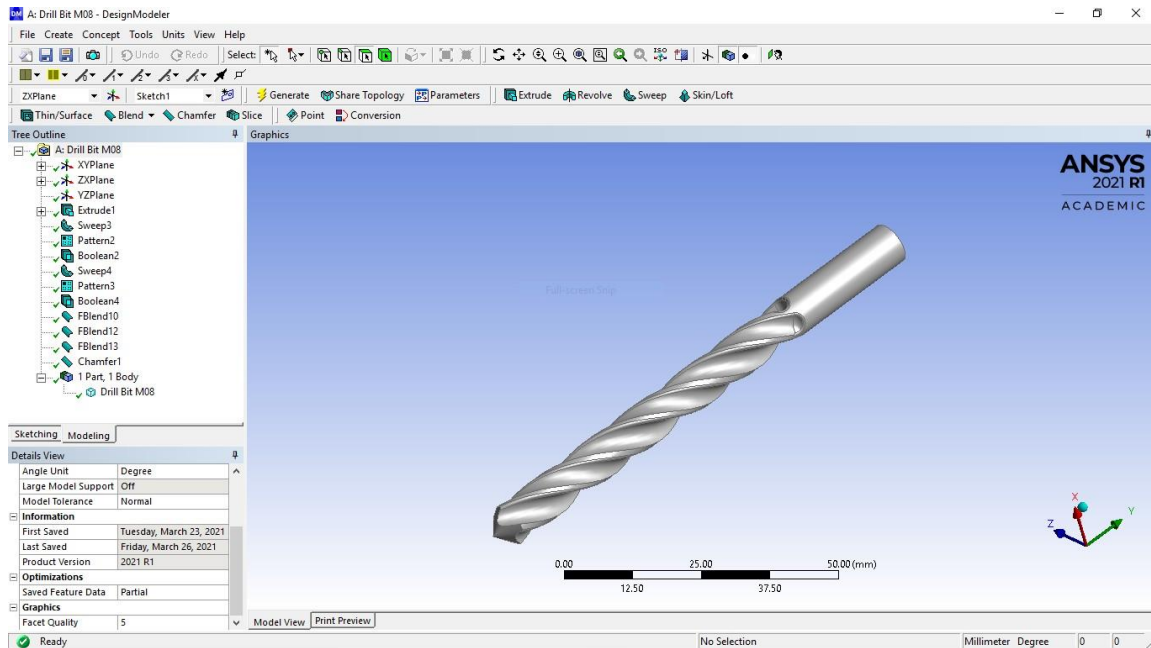


Fig 4.5 Importing M08 HSS Drill Bit

4.9.4 Importing M10 HSS End Mill Cutter

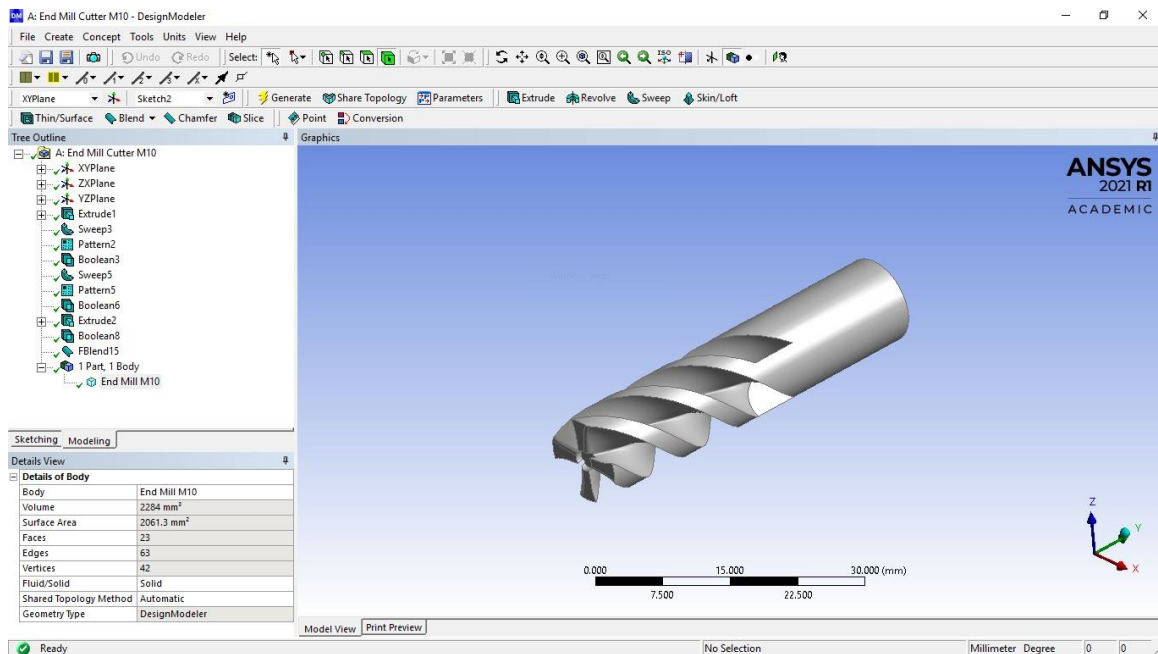


Fig 4.6 Importing M10 HSS End Mill Cutter

4.10 MESHING

Meshing is a discretization of a product into small number of nodes and elements. Meshing produces the foremost applicable mesh for accurate, economical Multiphysics solutions may be a general-purpose, intelligent, machine-driven high-performance product. Meshing is generated by automated meshing method. All the geometries are meshed in tetra shaped element.

4.10.1 Meshing M08 HSS Drill Bit

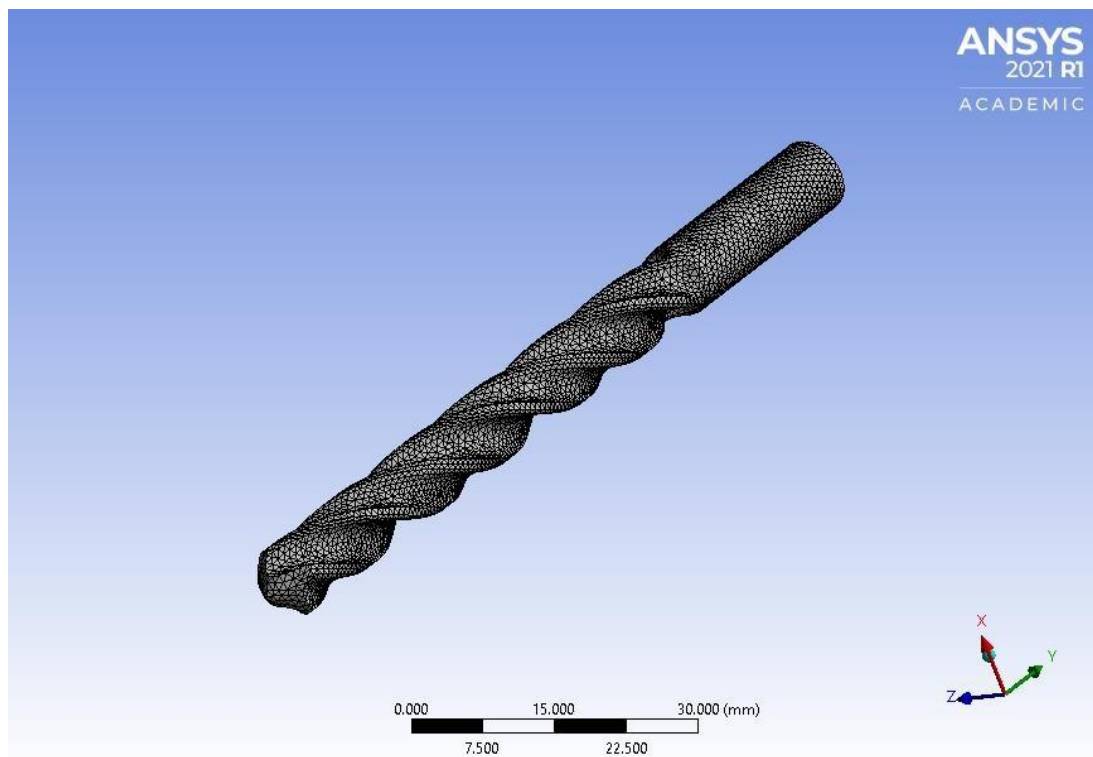


Fig 4.7 Meshing M08 HSS drill bit

Meshing Statistics

Mesh Sizing: 0.78 mm

Average surface area: 110.2 mm²

Minimum edge length: 0.55 mm

No of Nodes: 95006

No of Elements: 62996

4.10.2 Meshing M10 HSS End Mill Cutter

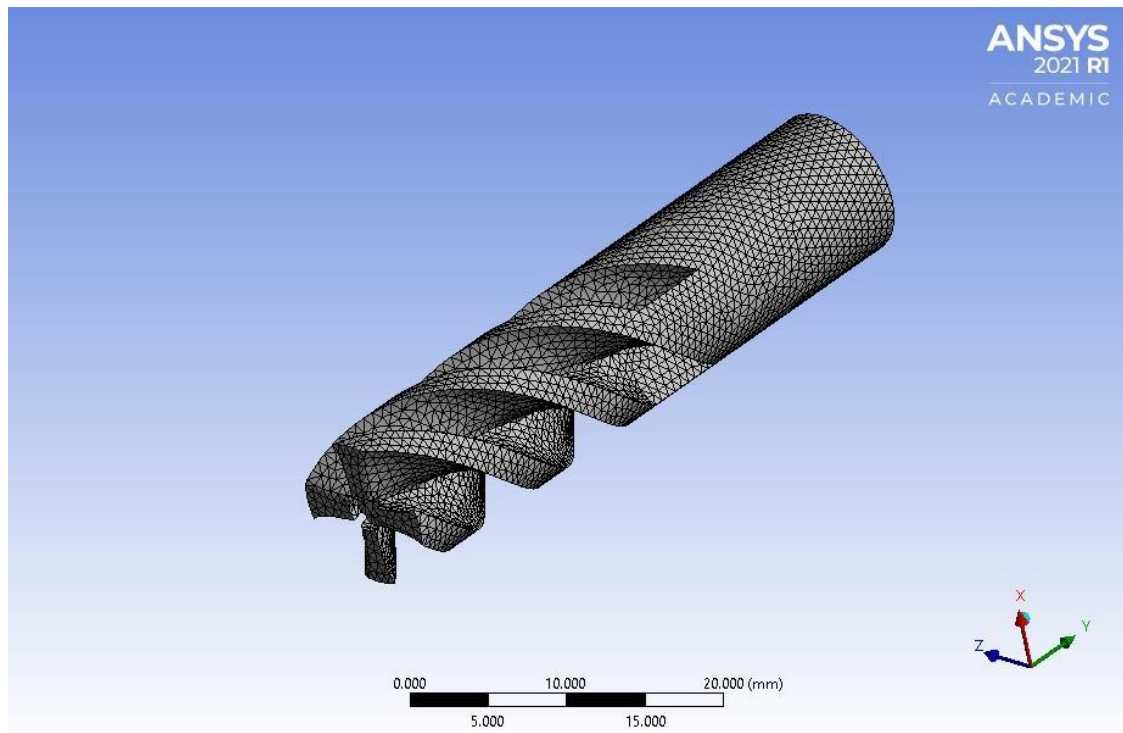


Fig 4.8 Meshing M10 HSS End Mill Cutter

Meshing Statistics

Mesh Sizing: 0.68 mm

Average surface area: 89.74 mm²

Minimum edge length: 0.4101 mm

No of Nodes: 95604

No of Elements: 63828

4.11 BOUNDARY CONDITION

The boundary condition for structural finite element analysis, the degree of freedom are displacements and the associated loads are forces. Assign the boundary conditions for a selected tool with common conditions.

A - Moment acts on body of the tools

B - Force acts on bottom of the tools

C - Fixed Support at top of tools.

4.11.1 Assign Boundary Condition for M08 Drill Bit

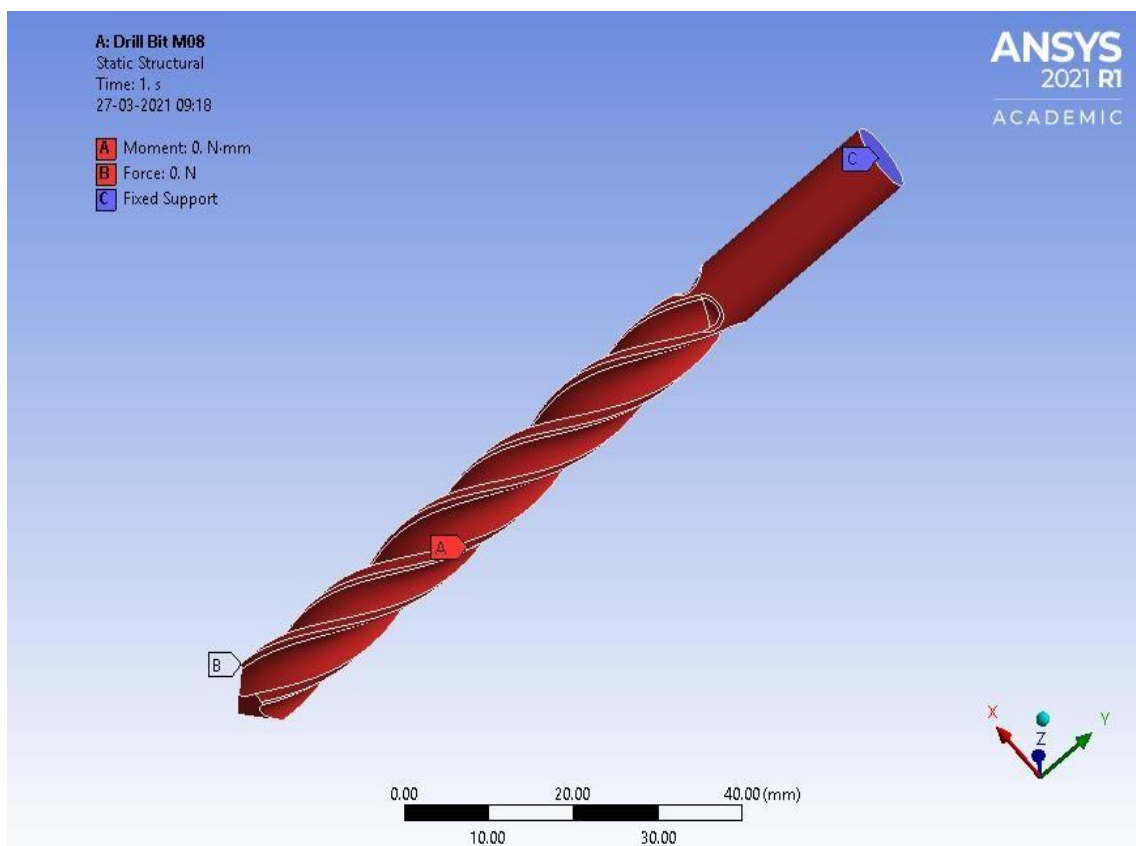


Fig 4.9 Boundary Condition for M08 Drill Bit

4.11.2 Assign Boundary Condition for M10 End Mill Cutter

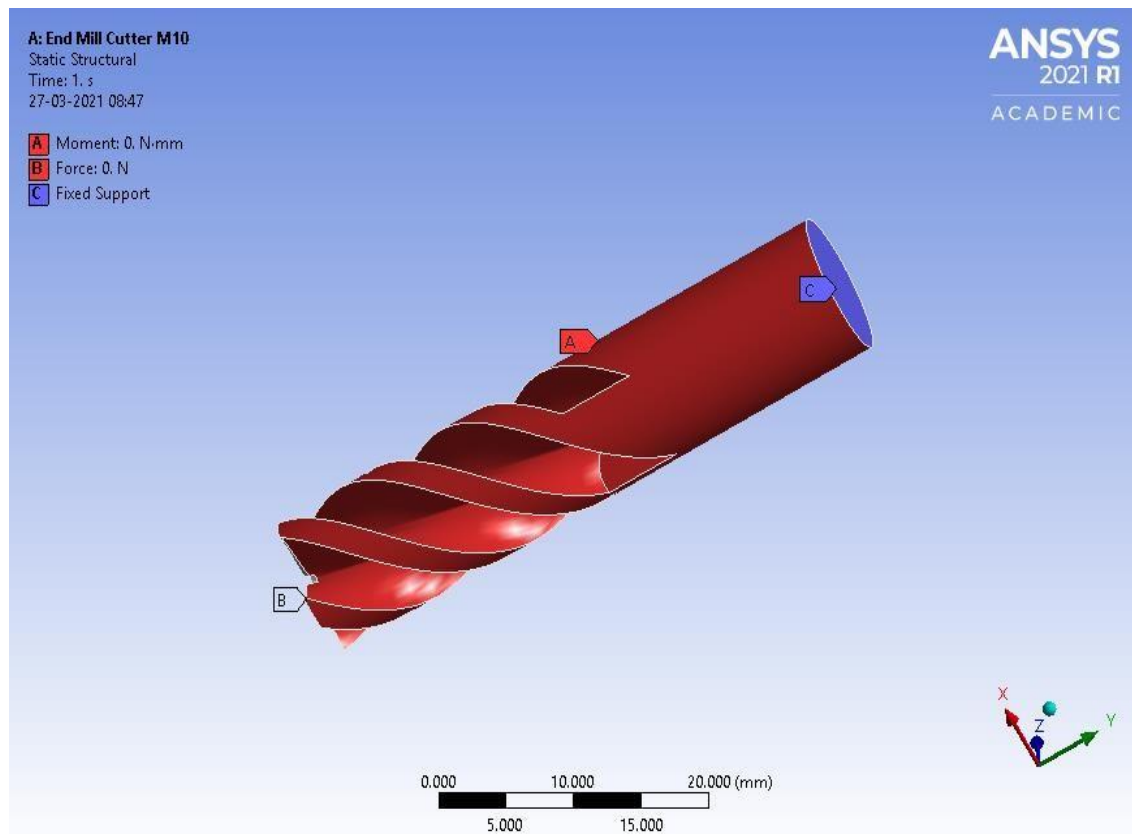


Fig 4.10 Boundary Condition for M10 End Mill Cutter

5. RESULT AND ANALYSIS

5.1 RESULT

The distributions of Equivalent Stress and strain in different milling and drilling tools considered with total deformation. The following table consists of total deformation, equivalent stress, equivalent strain and strain energy values obtained from ANSYS at M08 and M12 Drill bit and M10 End Mill Cutter.

5.1.1 MAXIMUM RESULTS OF M08 DRILL BIT

Level	Total Deformation (mm)	Maximum Strain	Maximum Stress (Mpa)	Strain Energy (MJ)
1	9.7855×10^{-3}	131.567×10^{-6}	30.633	14.029×10^{-5}
2	13.6670×10^{-3}	186.09×10^{-6}	43.323	27.14×10^{-5}
3	17.2390×10^{-3}	236.55×10^{-6}	55.07	42.997×10^{-5}
4	5.4578×10^{-3}	76.068×10^{-6}	17.712	4.4798×10^{-5}
5	7.7877×10^{-3}	106.77×10^{-6}	24.86	9.468×10^{-5}
6	9.7855×10^{-3}	131.56×10^{-6}	30.633	14.029×10^{-5}
7	3.8920×10^{-3}	57.722×10^{-6}	13.44	2.3383×10^{-5}
8	5.4573×10^{-3}	76.068×10^{-6}	17.712	4.4798×10^{-5}
9	6.9350×10^{-3}	92.635×10^{-6}	21.569	7.1386×10^{-5}

Table 5.1 Maximum results of M08 HSS drill bit

From the above table the maximum value of total deformation, equivalent strain and stress, strain energy occurred at **Level 3**. Representation of **Level 3** combination result in Ansys are shown below,

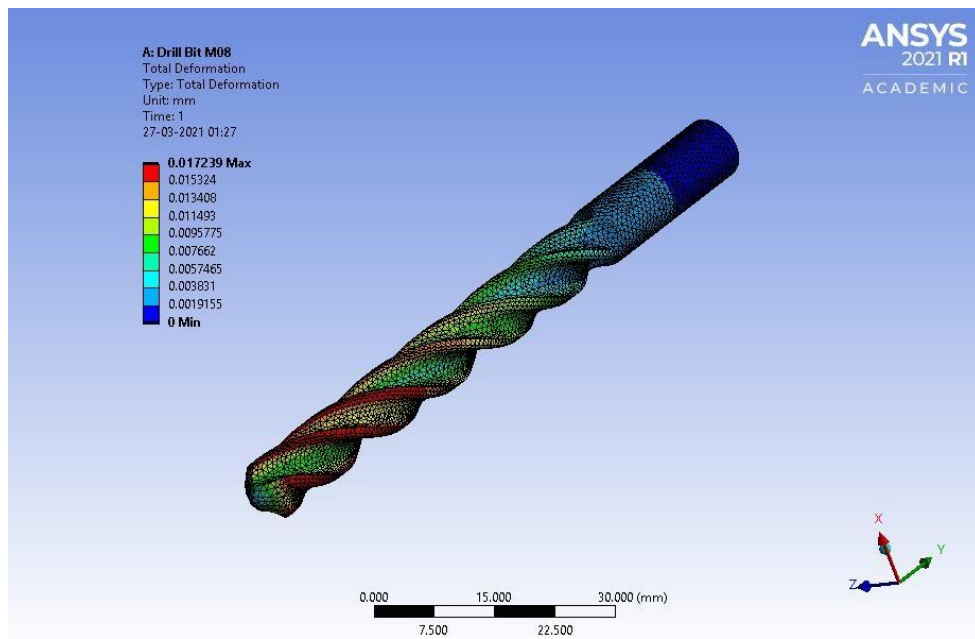


Fig 5.1 Maximum Total Deformation of M08

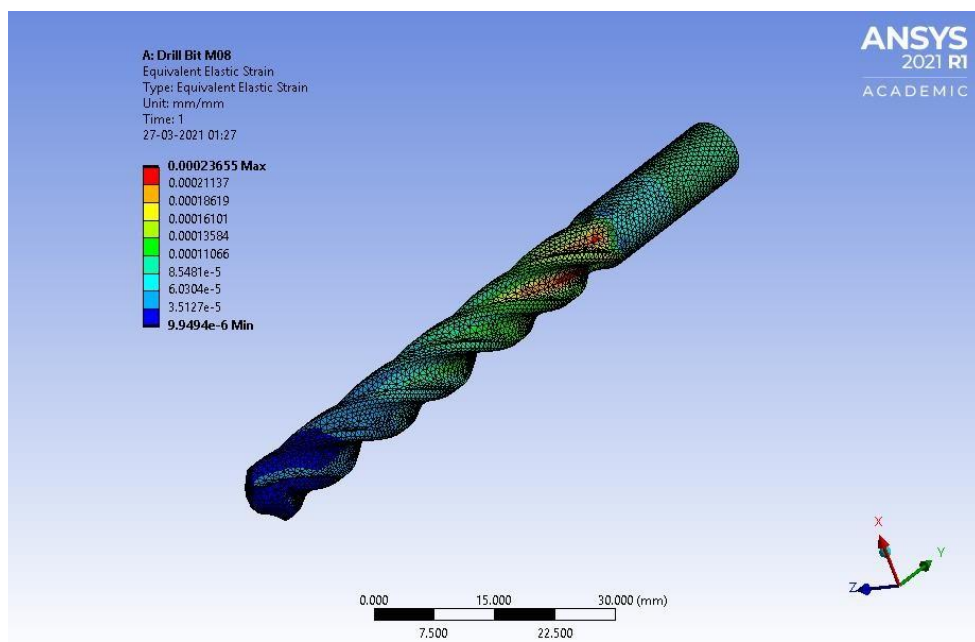


Fig 5.2 Maximum Equivalent Elastic strain of M08

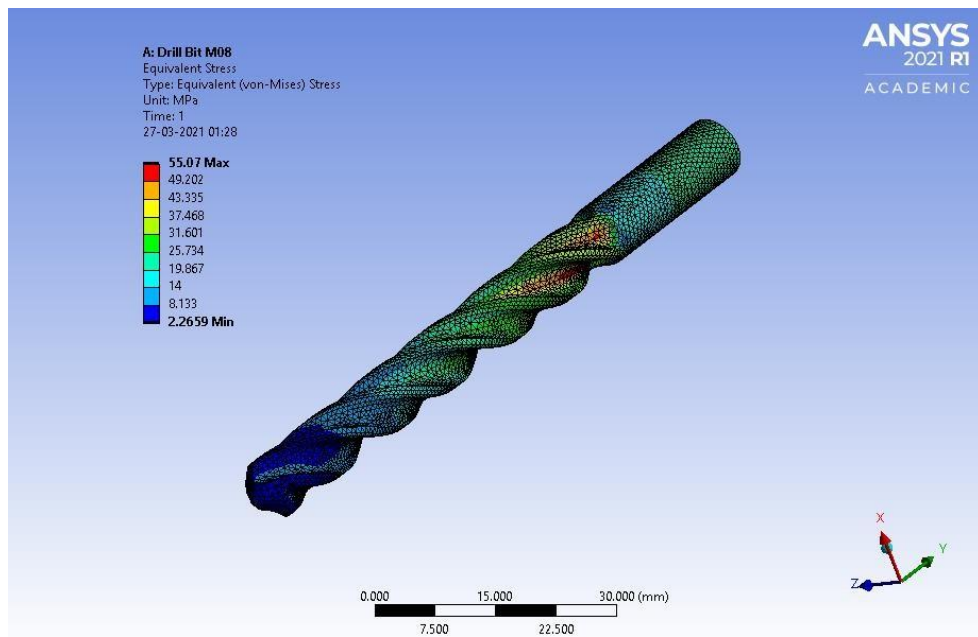


Fig 5.3 Maximum Equivalent Stress of M08

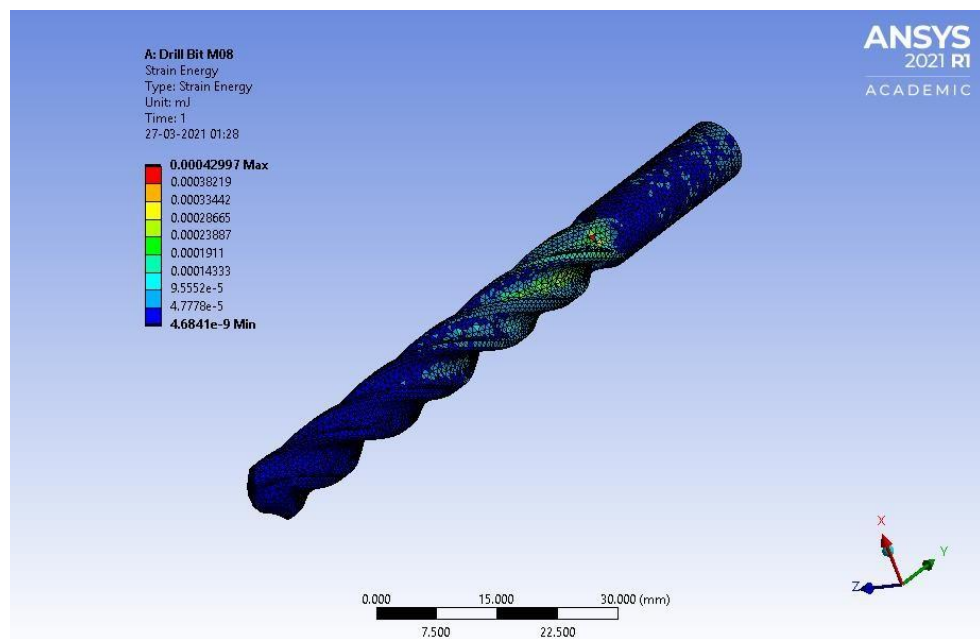


Fig 5.4 Maximum Strain Energy of M08

5.1.2 MINIMUM RESULT OF M08 HSS DRILL BIT

Level	Minimum Strain	Minimum Stress (Mpa)	Strain Energy (MJ)
1	7.8126×10^{-6}	1.8203	3.3734×10^{-9}
2	8.9617×10^{-6}	2.0881	4.0961×10^{-9}
3	9.9494×10^{-6}	2.2659	4.6841×10^{-9}
4	6.3833×10^{-6}	1.9875	2.9574×10^{-9}
5	7.1889×10^{-6}	1.675	2.9573×10^{-9}
6	7.8126×10^{-6}	1.8203	3.3734×10^{-9}
7	5.6833×10^{-6}	1.3242	2.0037×10^{-9}
8	6.3833×10^{-6}	1.4873	2.9574×10^{-9}
9	6.9111×10^{-6}	1.6103	2.7986×10^{-9}

Table 5.2 Minimum Results of M08 Drill Bit

From the above table the minimum value of total deformation, equivalent strain and stress, strain energy occurred at **Level 7**. Representation of **Level 7** combination result in Ansys are shown below,

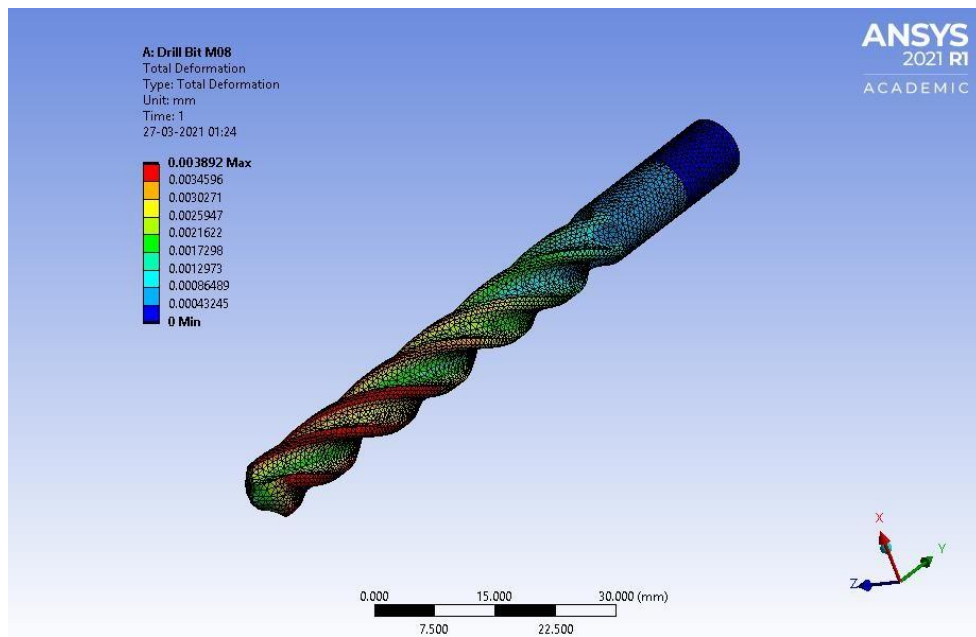


Fig 5.5 Minimum Total Deformation of M08

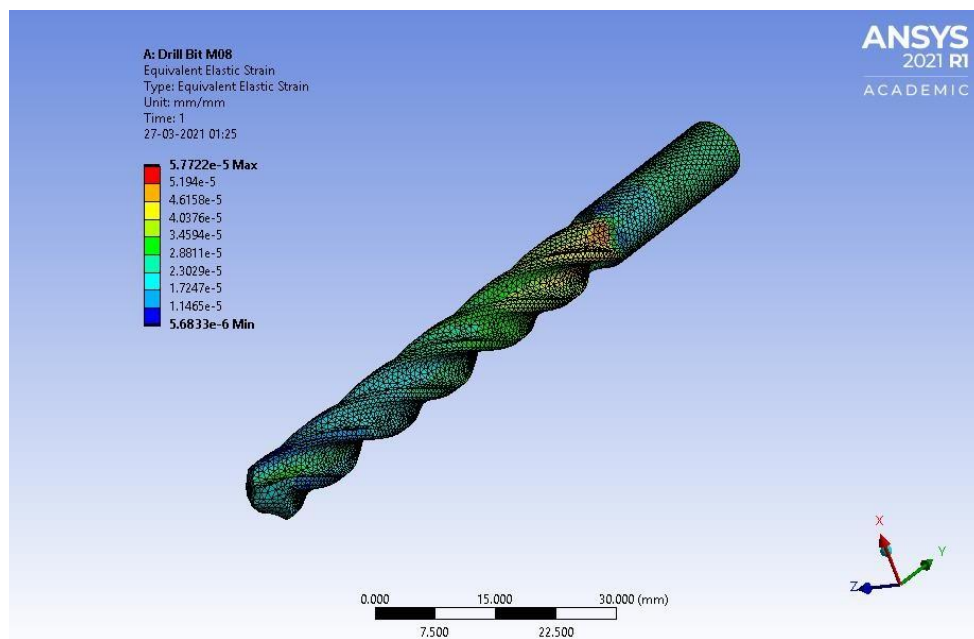


Fig 5.6 Minimum Equivalent Elastic strain of M08

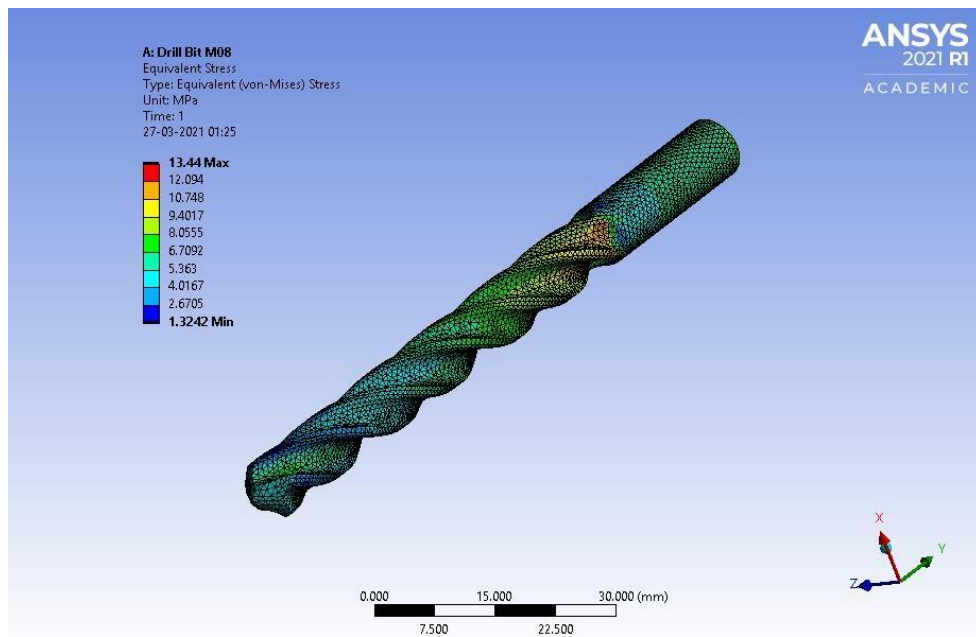


Fig 5.7 Minimum Equivalent Stress of M08

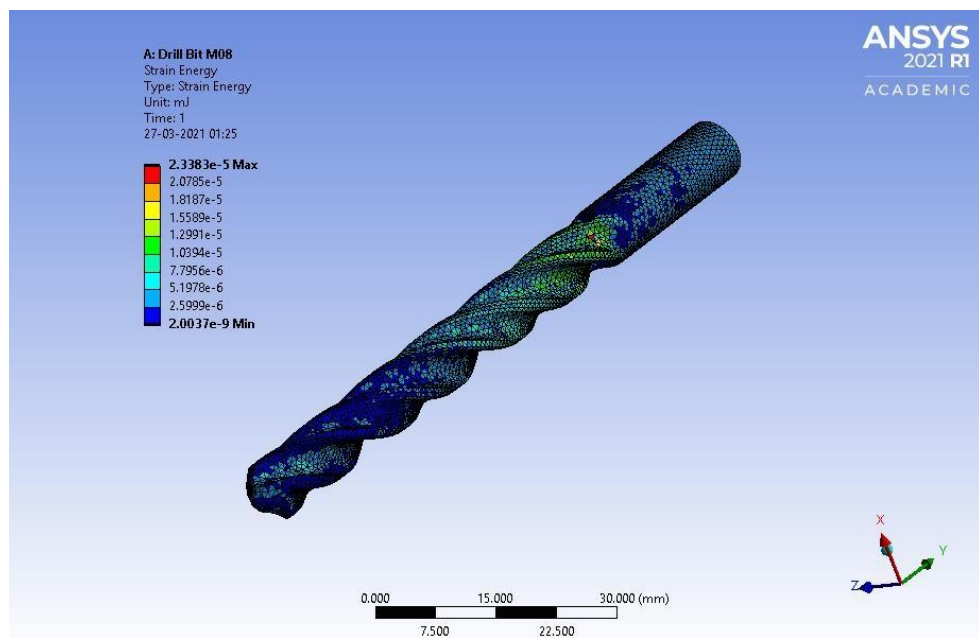


Fig 5.8 Minimum Strain Energy of M08

5.1.3 MAXIMUM RESULTS OF M10 END MILL CUTTER

Level	Total Deformation (mm)	Maximum Strain	Maximum Stress (MPa)	Strain Energy (MJ)
1	0.6530×10^{-3}	6.2089×10^{-5}	13.1620	6.8837×10^{-6}
2	1.9547×10^{-3}	18.5870×10^{-5}	39.4030	61.6870×10^{-6}
3	3.9121×10^{-3}	37.1940×10^{-5}	78.8480	247.02×10^{-6}
4	0.6533×10^{-3}	6.2089×10^{-5}	13.1620	6.8837×10^{-6}
5	1.4705×10^{-3}	13.9480×10^{-5}	29.5700	34.745×10^{-6}
6	0.6533×10^{-3}	6.2089×10^{-5}	13.1620	6.8337×10^{-6}
7	0.6506×10^{-3}	6.1890×10^{-5}	13.1200	6.8394×10^{-6}
8	0.2261×10^{-3}	2.0935×10^{-5}	4.4397	0.7838×10^{-6}
9	0.8790×10^{-3}	8.3023×10^{-5}	17.6020	12.3130×10^{-6}

Table 5.3 Maximum Results of M10 End Mill Cutter

From the above table the maximum value of total deformation, equivalent strain and stress, strain energy occurred at **Level 3**. Representation of **Level 3** combination result in Ansys are shown below,

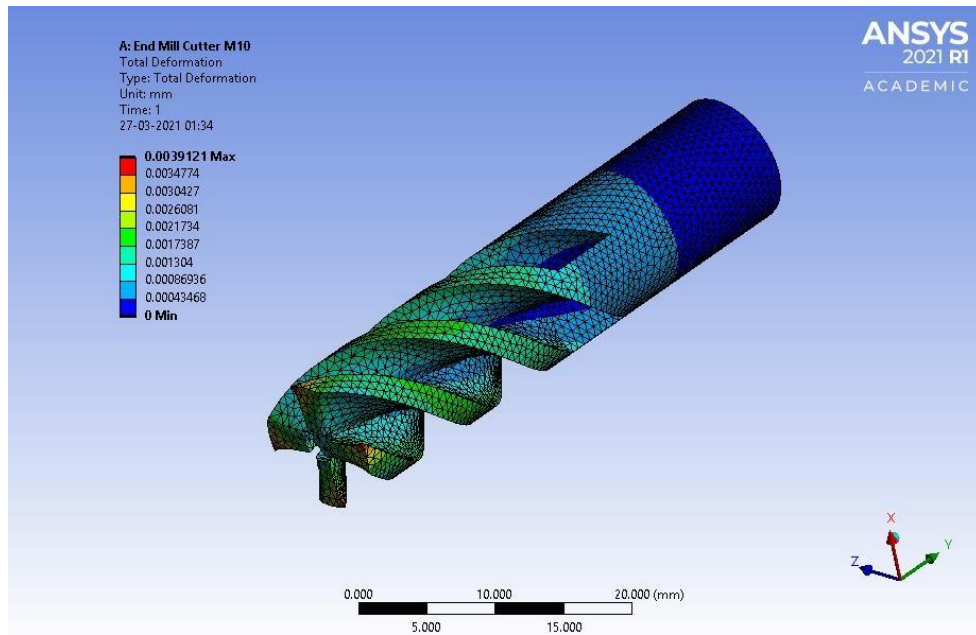


Fig 5.9 Maximum Total Deformation of M10

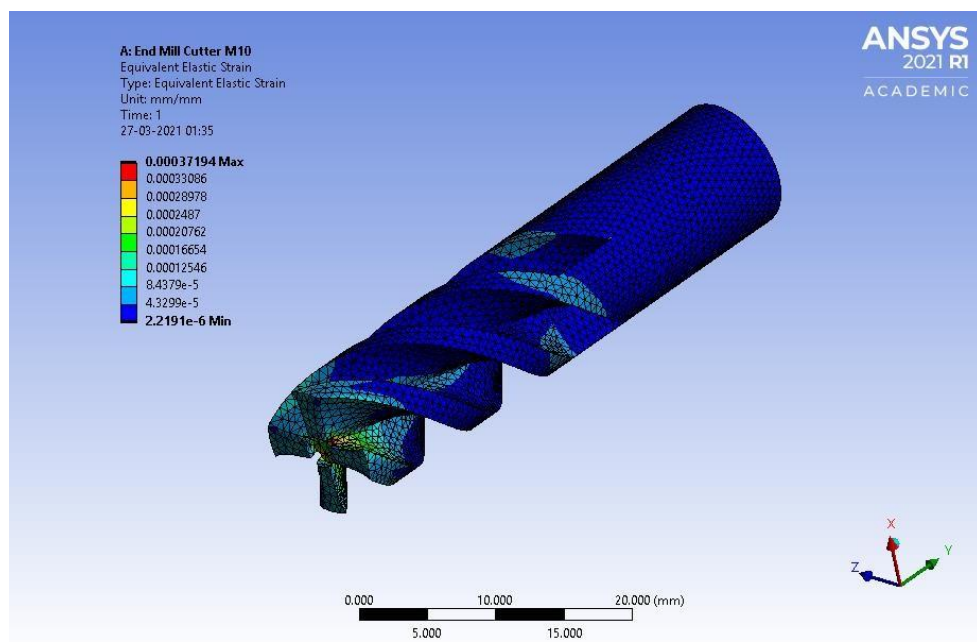


Fig 5.10 Maximum Equivalent Elastic strain of M10

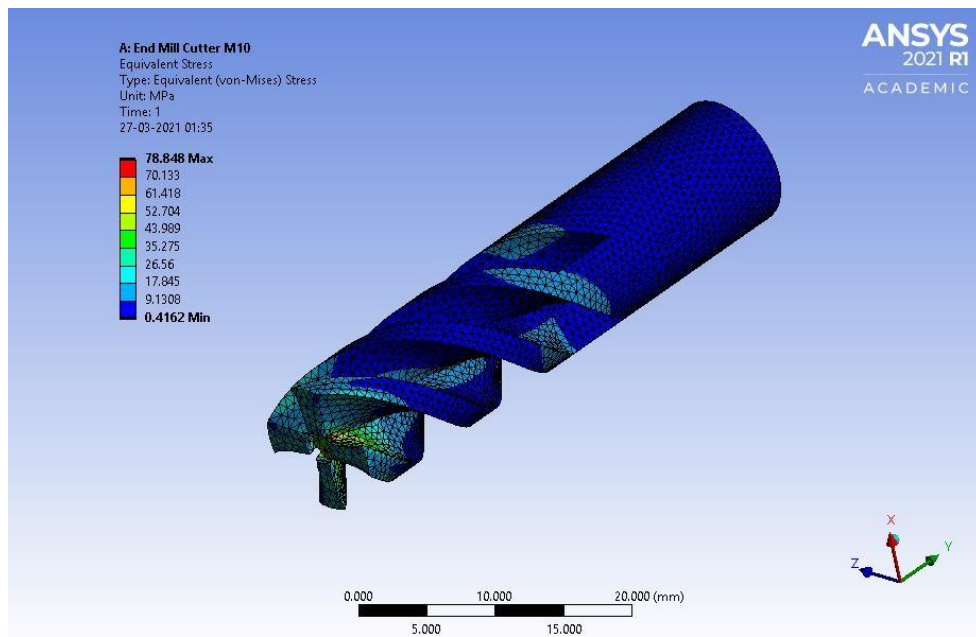


Fig 5.11 Maximum Equivalent Stress of M10

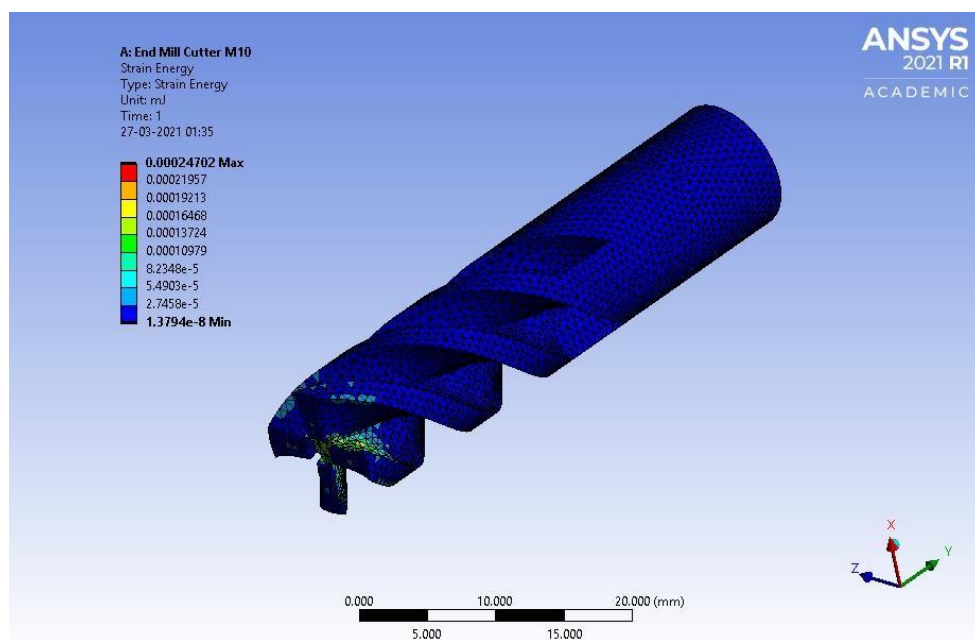


Fig 5.12 Maximum Strain Energy of M10

5.1.4 MINIMUM RESULTS OF M10 END MILL CUTTER

Level	Minimum Strain	Minimum Stress (Mpa)	Strain Energy (mJ)
1	0.0365×10^{-5}	0.0689	3.8766×10^{-10}
2	0.1113×10^{-5}	0.2085	34.3530×10^{-10}
3	0.2219×10^{-5}	0.4162	137.94×10^{-10}
4	0.0368×10^{-5}	0.0689	3.8766×10^{-10}
5	0.0779×10^{-5}	0.1498	20.3940×10^{-10}
6	0.0365×10^{-5}	0.0689	3.8766×10^{-10}
7	0.0373×10^{-5}	0.0698	3.7885×10^{-10}
8	0.0086×10^{-5}	0.0199	0.5372×10^{-10}
9	0.0415×10^{-5}	0.0842	8.0654×10^{-10}

Table 5.4 Minimum Results of M10 End Mill Cutter

From the above table the minimum value of total deformation, equivalent strain and stress, strain energy occurred at **Level 8**. Representation of **Level 8** combination result in Ansys are shown below,

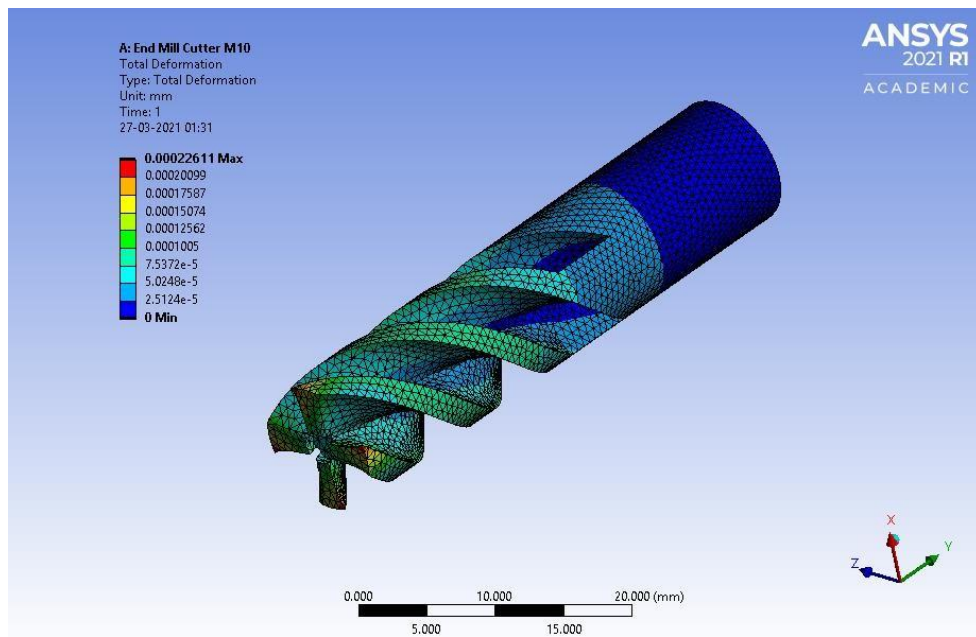


Fig 5.13 Minimum Total Deformation of M10

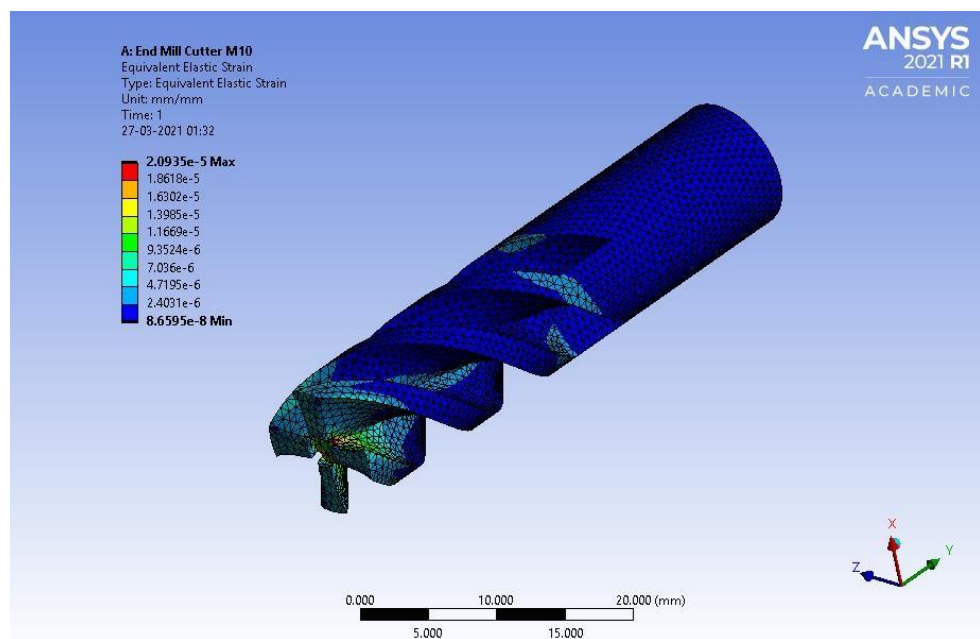


Fig 5.14 Minimum Equivalent Elastic strain of M10

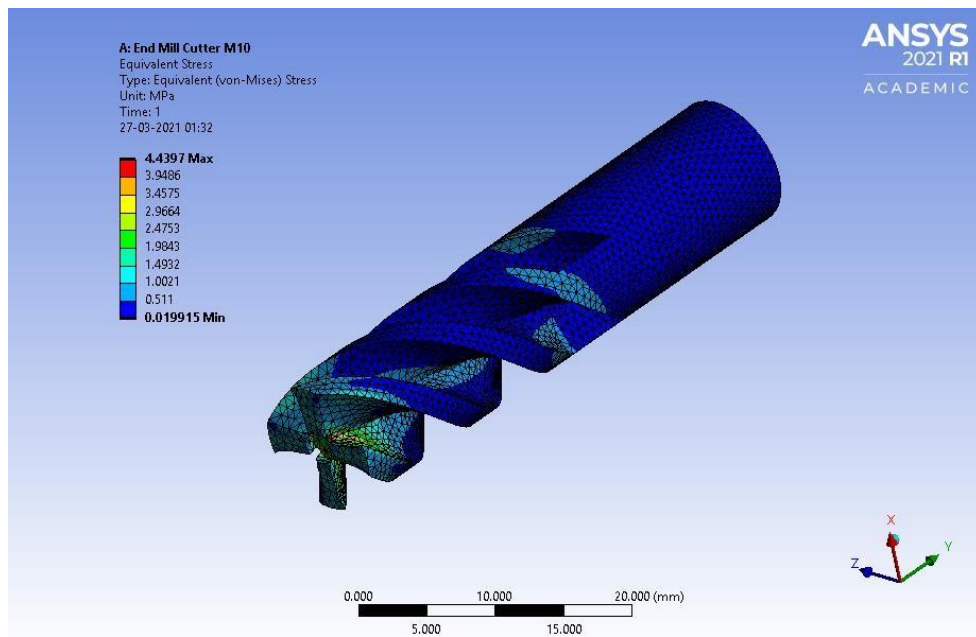


Fig 5.15 Minimum Equivalent Stress of M10

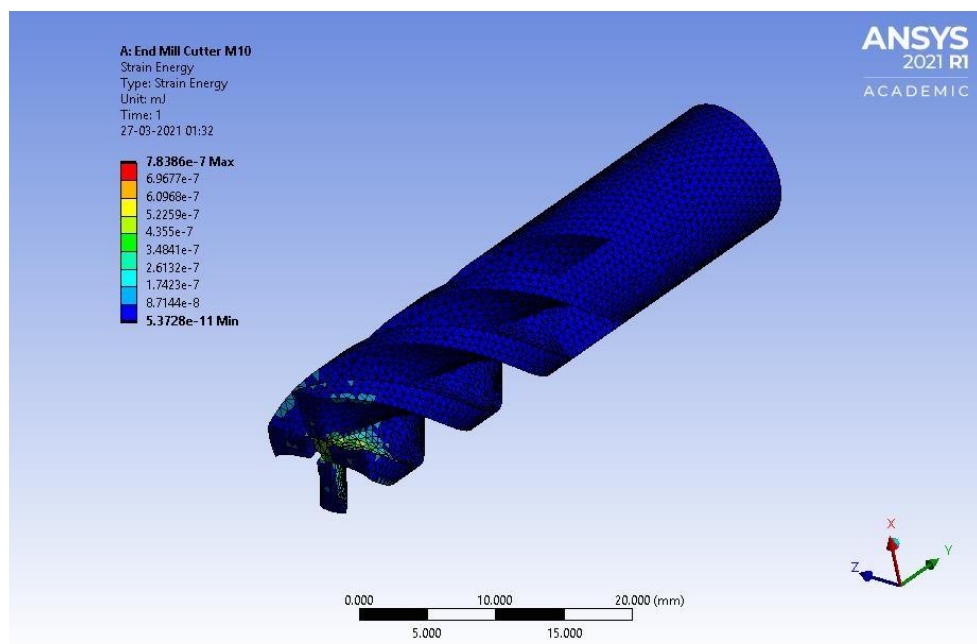


Fig 5.16 Minimum Strain Energy of M10

5.2 ANALYSIS

The analysis of combination of cutting tool parameters and its result are found using ANSYS software and various graph are plotted using the results obtained above.

5.3 STATISTICAL ANALYSIS

It is a completely convenient device to get faulty answers when the authentic technique could be very complex or now not identified in its actual shape. It additionally gives an most excellent set of input parameters to identify the effect of every on a given output. Taguchi approach emphasizes over the selection of the maximum first-rate solution over the set of specific inputs with a reduced fee and magnified high-quality. Thus, the trendy day method to are searching for out the fantastic output over a hard and fast of given input are often virtually function out via the employment of Taguchi method.

5.4 TAGUCHI METHOD

The Taguchi technique could be a control tool to identify the results of different greatly reduced variance for experiments with optimal parameter settings for method management. During this work L9 orthogonal array mixed was accustomed do the experiments and therefore the experimental result was analyzed mistreatment Taguchi tech Since the investigational layout is orthogonal, it turned into likely to wonderful out the realization of every parameter at modified levels. Graph plotted among Input parameter (speed, feed, and intensity of cut) and output the usage of above. So as to measure the variability of the outcomes among a pre-defined vary.

5.5 GRAPH

The various graphs are plotted by the given results of total deformation, equivalent stress and strain and strain energy for the combination of cutting tool parameter analysis results.

5.5.1 TOTAL DEFORMATION

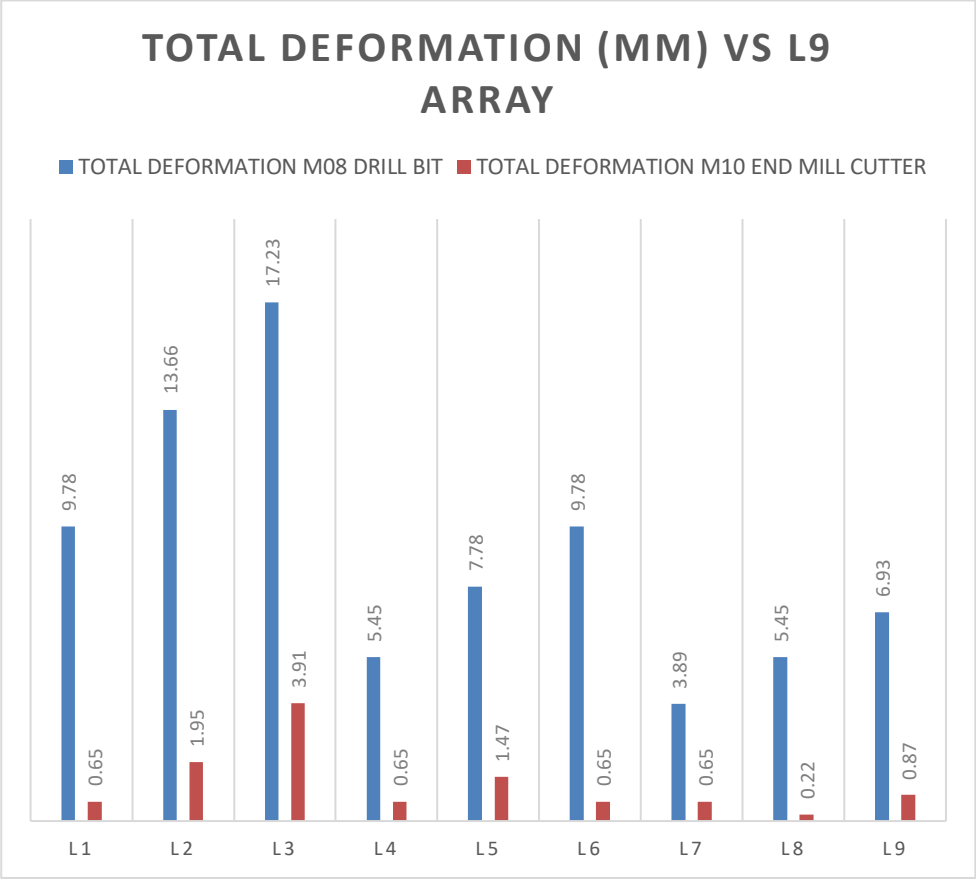


Fig 5.17 Total Deformation (mm) vs L9 Array

The graphical chart represents the total deformation of each tool in various levels of combination of cutting tool parameters.

5.5.2 MINIMUM ELASTIC STRAIN

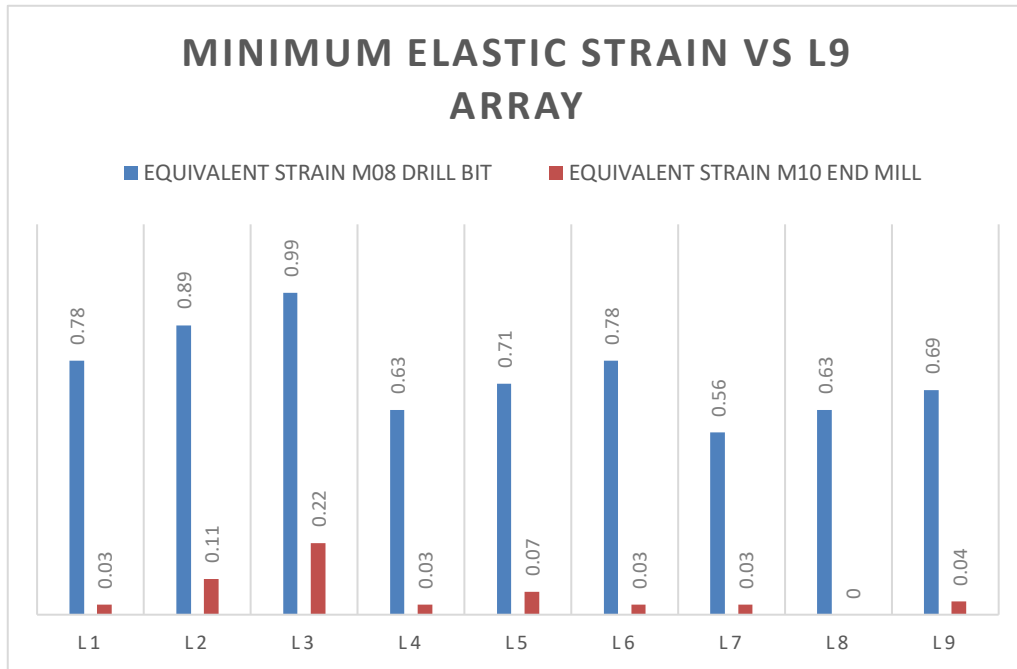


Fig 5.18 Minimum Elastic Strain (mm) vs L9 Array

5.5.3 MAXIMUM ELASTIC STRAIN

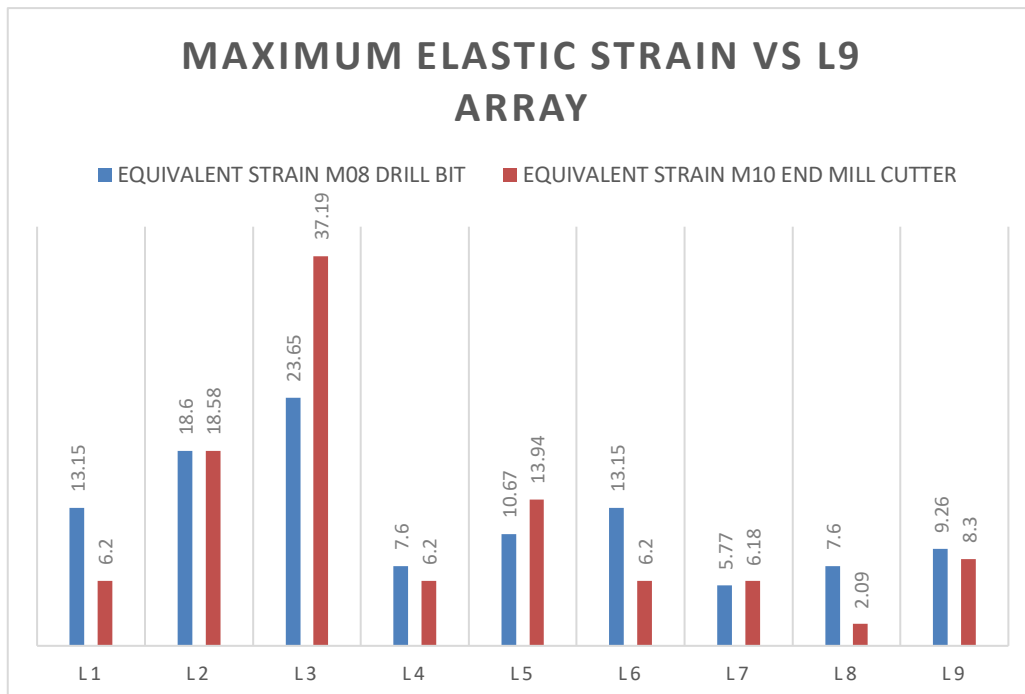


Fig 5.19 maximum Elastic Strain vs L9 Array

5.5.4 MINIMUM EQUIVALENT STRESS

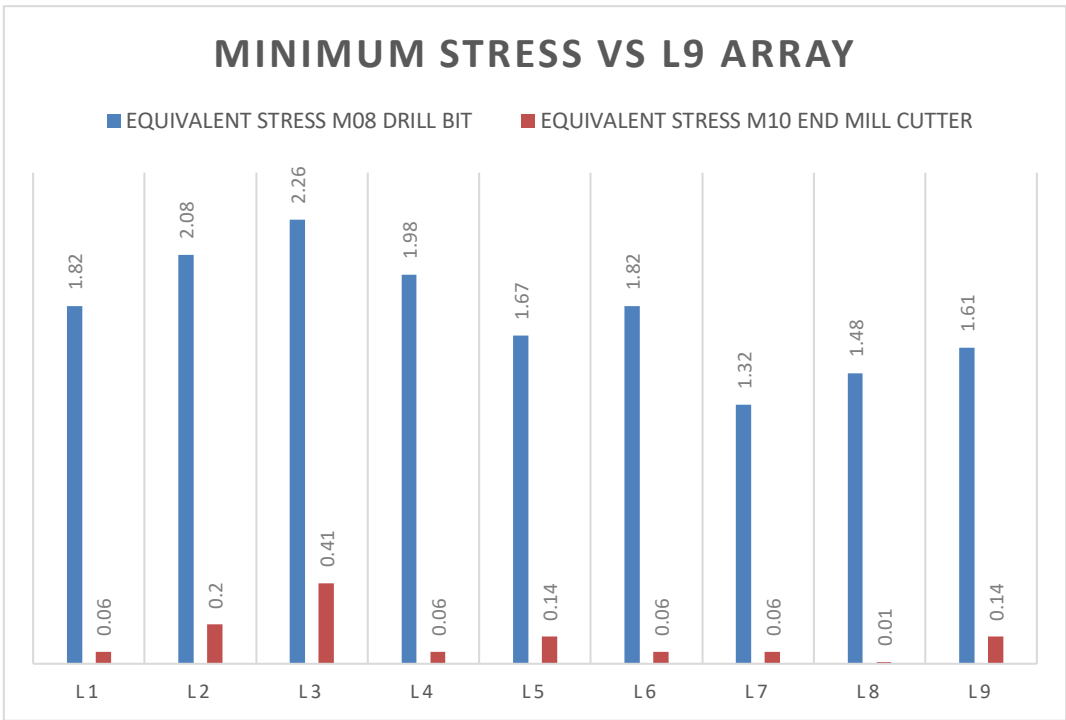


Fig 5.20 Minimum Stress vs L9 Array

5.5.5 MAXIMUM EQUIVALENT STRESS

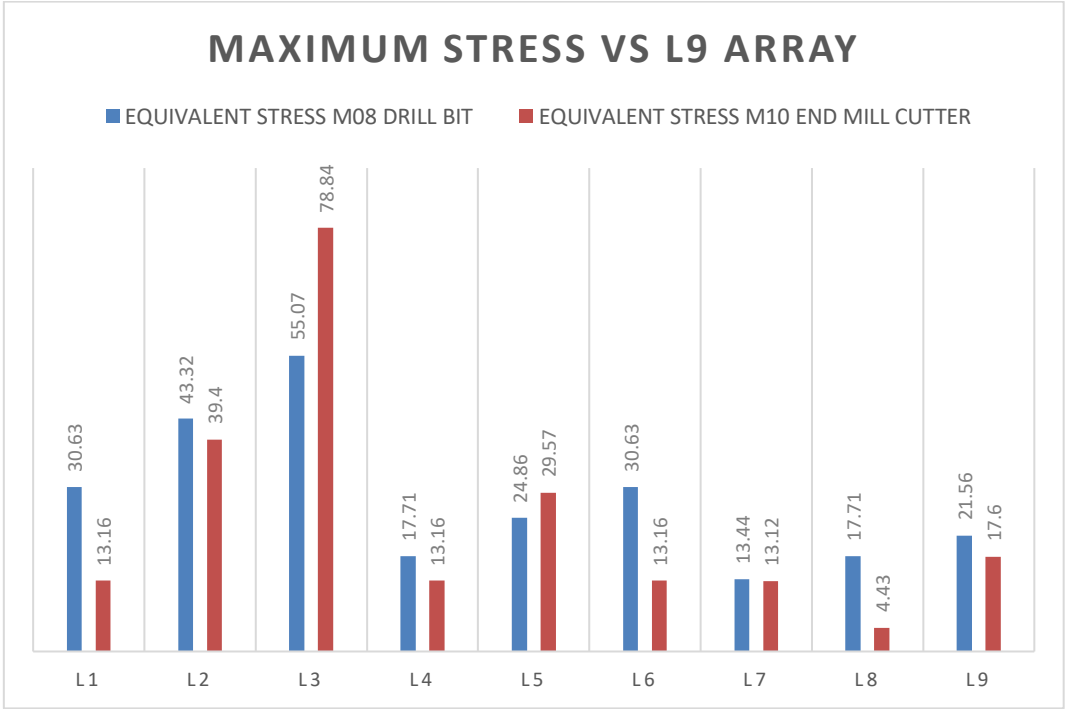


Fig 5.21 Maximum Stress vs L9 Array

6. SUMMARY AND CONCLUSION

From the project we can conclude that effect of cutting forces on tool during machining process place a vital role in highspeed machining process. In order to obtain greater accuracy, surface finish and tool life we need to select the appropriate combination of cutting tool parameters. The best cutting tool parameter combination were found on different cutting tools we suggest this combination of cutting parameters will increase the machining capacity, machinability, accuracy, surface finish and tool life. Each combination of cutting tool parameter will decrease stress acting on the tool thus it improves the tool life to a greater extend. Various graph is interpreted from that we conclude Level 3 has highest values of total deformation, Equivalent strain and stress, strain energy. Level 8 has the lowest values of total deformation, Equivalent strain and stress, strain energy for end mill cutter (M10) and Level 7 for drill bit (M08).

The below table 6.1 mentions the optimum cutting tool parameters for various tools in order to decrease stress acting on the tool and to increase the tool efficiency to greater extend.

Cutting Tools	Levels	Equivalent Elastic Stress (Mpa)	Equivalent Elastic Strain	Total Deformation (mm)
M08 Drill Bit	L7	1.3242	5.6833×10^{-6}	3.8920×10^{-3}
M10 End Mill Cutter	L8	0.0199	0.0086×10^{-5}	0.2261×10^{-3}

Table 6.1 Results of Optimum cutting tool parameters

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