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# A Study on the Influence of Cutting Parameters Like Thrust Force and Torque in Drilling Operations by Simulation

**SVY Sastry**
**Kakinada Institute of Technology and Science, Divili, Andhra Pradesh, India.**

**Sri. AV Sridhar**
**Kakinada Institute of Technology and Science, Divili, Andhra Pradesh, India.**

**Sri.S.Rajasekhar**
**Kakinada Institute of Technology and Science, Divili, Andhra Pradesh, India.**

## ABSTRACT:

This paper discusses the influence of cutting parameters in drilling of glass fiber reinforced composites, Mild Steel and Aluminum alloy. The experiments are conducted to study the effect of point angle, spindle speed and feed rate on thrust force and torque using HSS twist drills. This paper presents a mathematical model for correlating the interactions of drilling parameters and their effects on thrust force and torque. The optimum value of cutting parameters is also determined to get minimum value of thrust force and torque. In thesis, diameter of drilling cutting tool is 12mm, 8mm. theoretical calculations are done to calculate thrust force and torque. The assembly of work piece and tool are modeled in Pro/Engineer. The input parameters considered are point angle $118^0$ and $120^0$, tool diameter, spindle speed, feed rate and materials. Different combinations of the above parameters are considered to get the minimum value of thrust force and torque. Structural analysis is done on the assembly to verify the stresses for different materials Mild Steel, Aluminum alloy and composite material E Glass Epoxy. Analysis is done in Ansys.

## INTRODUCTION:

Drilling is a cutting process that uses a drill bit to cut or enlarge a hole of circular cross-section in solid materials. The drill bit is a rotary cutting, often multipoint. The bit is pressed against the workpiece and rotated at rates from hundreds to thousands of revolutions per minute. This forces the cutting edge against the work piece, cutting off chips (swarf) from the hole as it is drilled. Small to medium-sized drilling rigs are mobile, such as those used in mineral exploration drilling, blast-hole, water wells and environmental investigations. Larger rigs are capable of drilling through thousands of metres of the Earth's crust, using large "mud pumps" to circulate drilling mud (slurry) through the drill bit and up the casing annulus, for cooling and removing the "cuttings" while a well is drilled. Hoists in the rig can lift hundreds of tons of pipe. Other equipment can force acid or sand into reservoirs to facilitate extraction of the oil or natural gas; and in remote locations there can be permanent living accommodation and catering for crews (which may be more than a hundred). Marine rigs may operate thousands of miles distant from the supply base with infrequent crew rotation or cycle.

## DRILL:

A **drill** is a tool fitted with a cutting tool attachment or driving tool attachment, usually a drill bit or driver bit,used for boring holes in various materials or fastening various materials together with the use of fasteners. The attachment is gripped by a chuck at one end of the drill and rotated while pressed against the target material.

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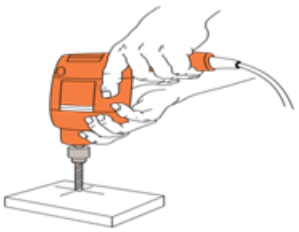
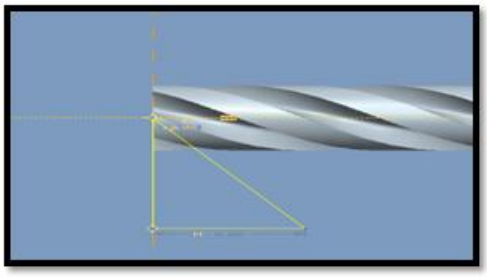
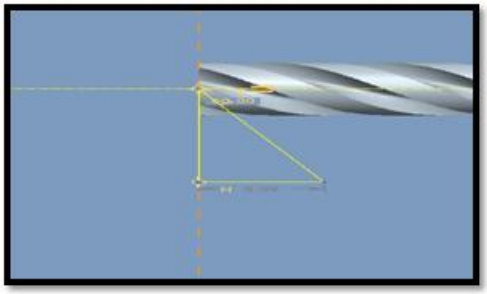
The tip, and sometimes edges, of the cutting tool does the work of cutting into the target material. This may be slicing off thin shavings (twist drills or auger bits), grinding off small particles (oil drilling), crushing and removing pieces of the work piece (SDS masonry drill), countersinking, counter boring, or other operations. Drills are commonly used in woodworking, metalworking, construction and do-it-yourself projects. Specially designed drills are also used in medicine, space missions and other applications. Drills are available with a wide variety of performance characteristics, such as power and capacity.



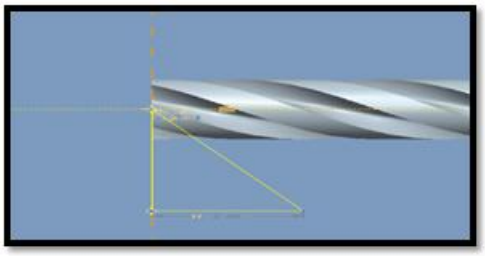
**MODELS OF DRILLING TOOL AND WORKPIECE**
**DIAMETER – 8mm**
**$118^0$ ANGLE CUT**



**$120^0$ ANGLE CUT**



**DIAMETER -12mm**
**$118^0$ANGLE CUT**



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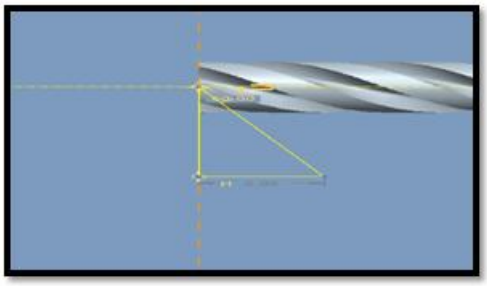
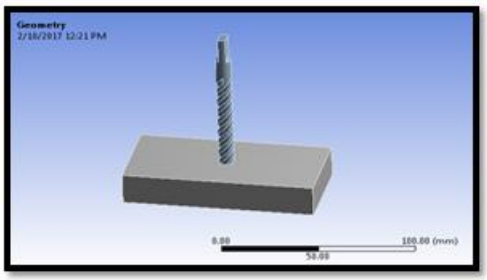


**STRUCTURAL ANALYSIS OF DRILLING TOOL**
**8mmDIAMETER - $118^0$ ANGLE**
**MATERIAL –ALUMINIUM**
**FORCE – 600 N**

**IMPORTED MODEL**



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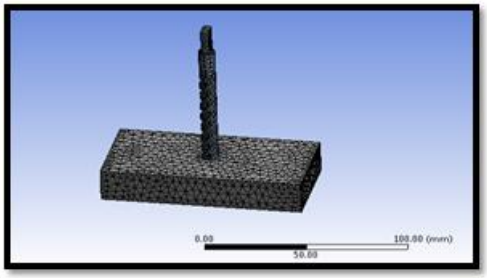

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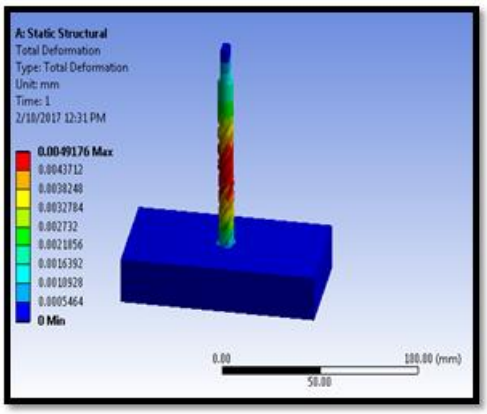
**TOTAL DEFORMATION**

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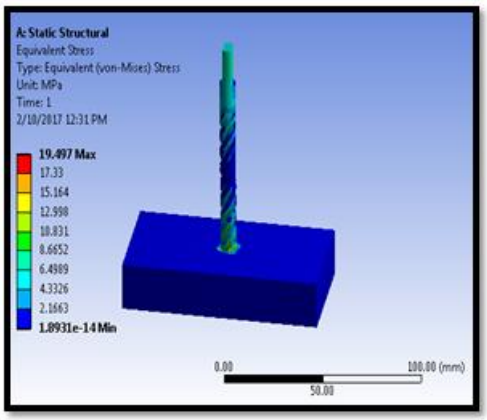


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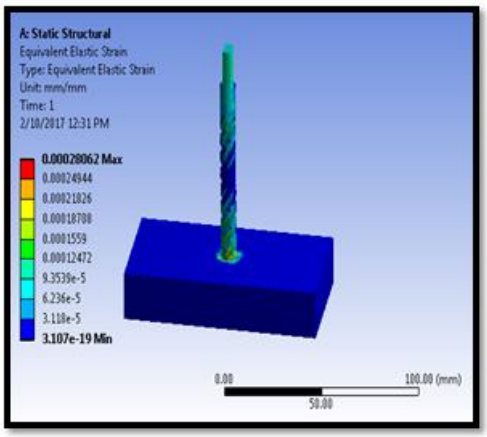
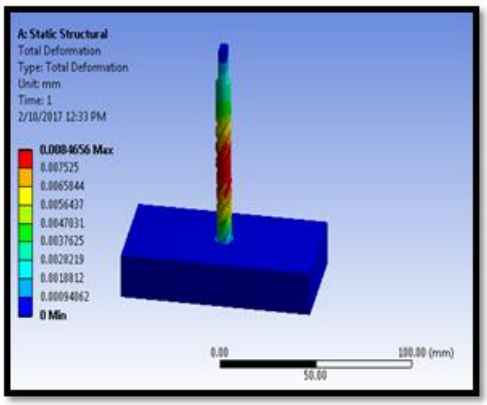



**MATERIAL –TITANIUM ALLOY**
**FORCE – 1400 N**

**TOTAL DEFORMATION**

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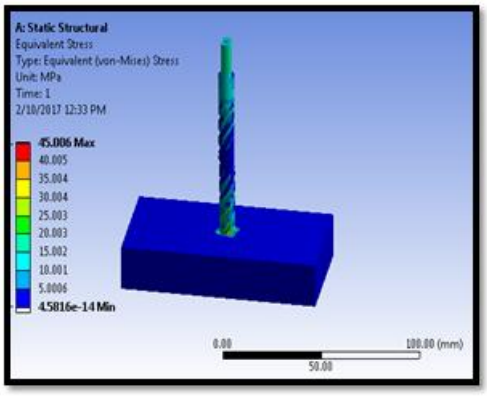


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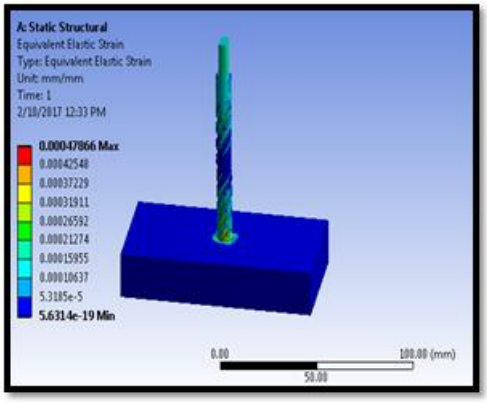


**MATERIAL –E GLASS EPOXY**
**FORCE – 416 N**

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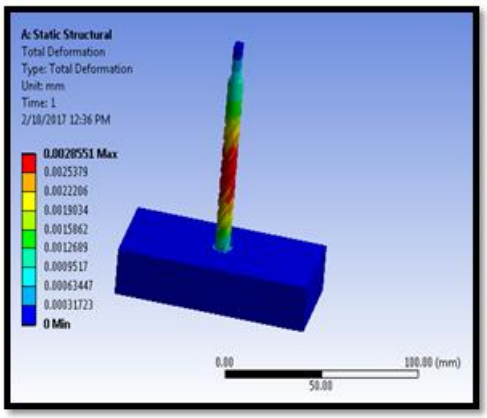
**TOTAL DEFORMATION**

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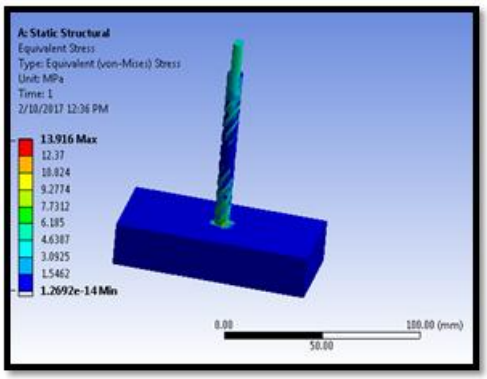


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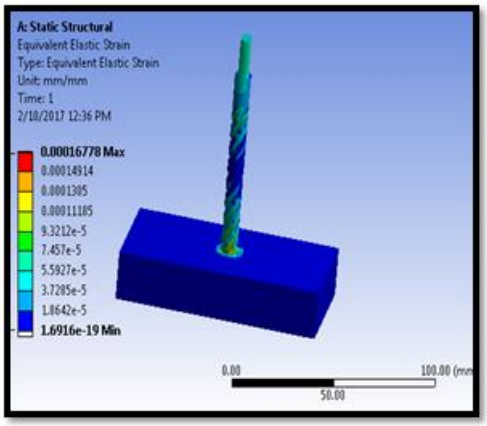
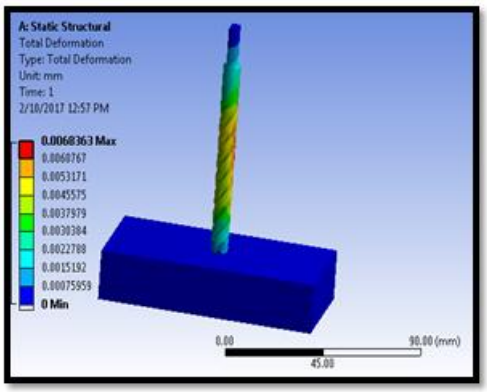



**8mmDIAMETER - 120$^0$ ANGLE**
**MATERIAL –ALUMINUM**
**Force – 600 N**

**TOTAL DEFORMATION**

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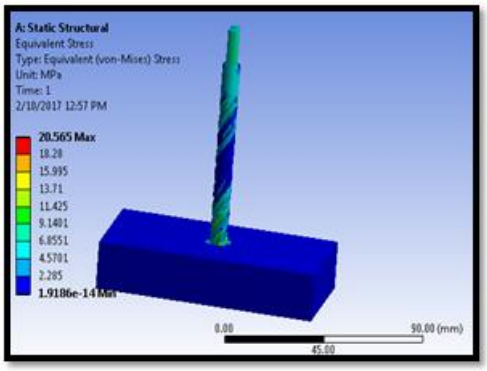


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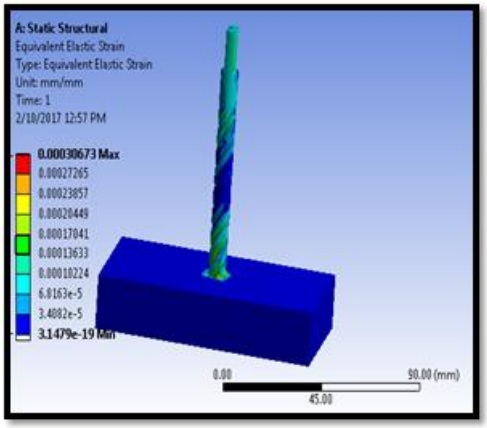


**MATERIAL –TITANIUM ALLOY**
**FORCE – 1400 N**

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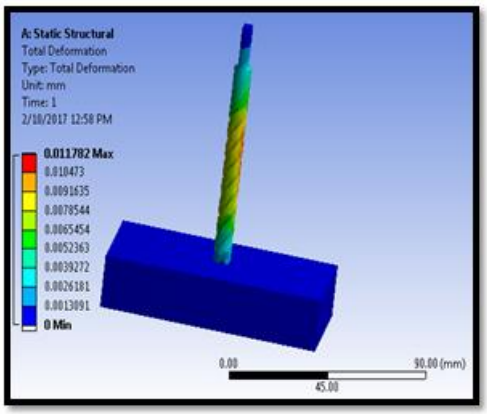
**TOTAL DEFORMATION**

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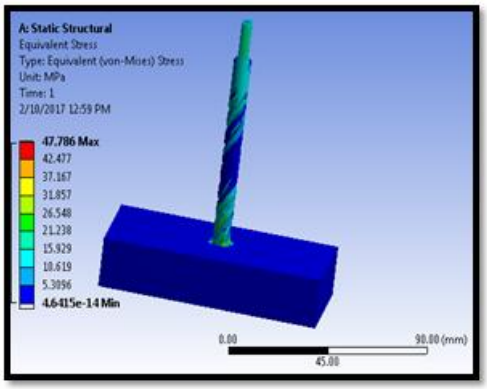


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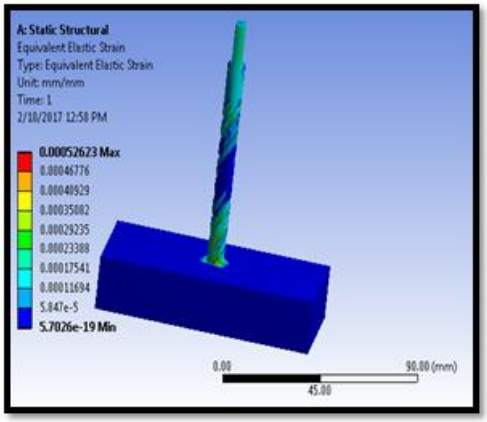
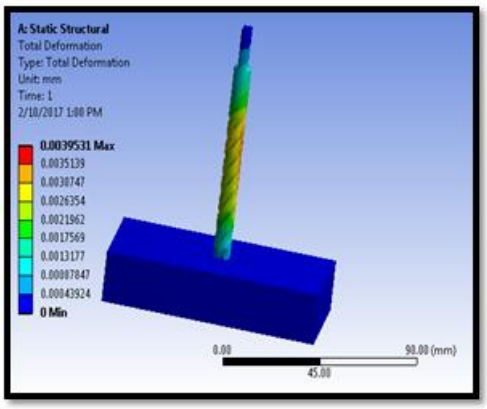



**MATERIAL –E GLASS EPOXY**
**FORCE – 416 N**

**TOTAL DEFORMATION**

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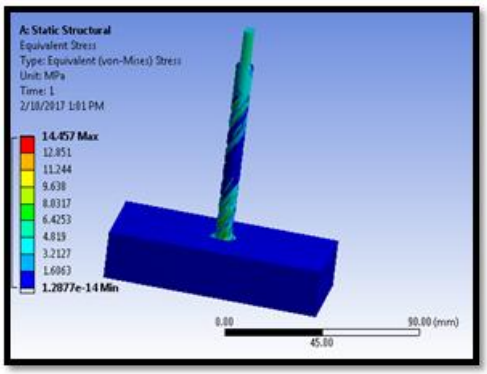


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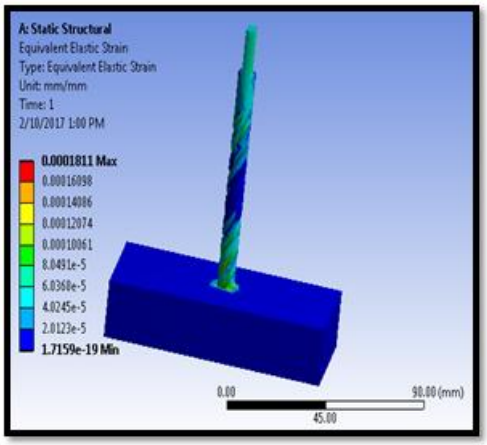


**12mm DIAMETER - $118^0$ ANGLE**
**MATERIAL –ALUMINIUM**
**FORCE – 900 N**

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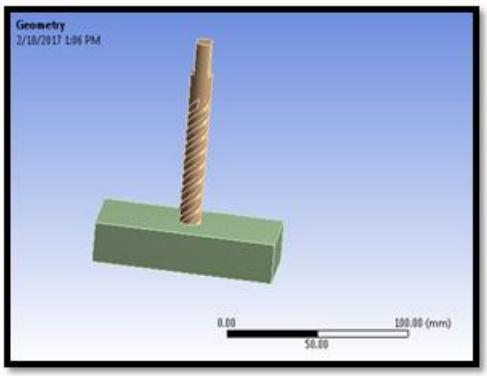
## IMPORTED MODEL

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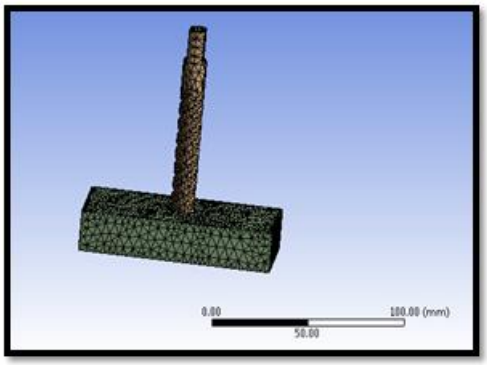


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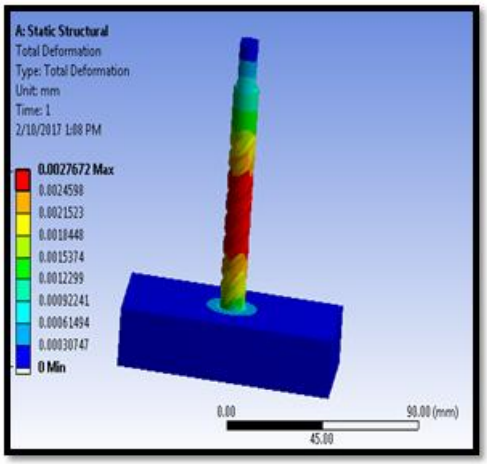


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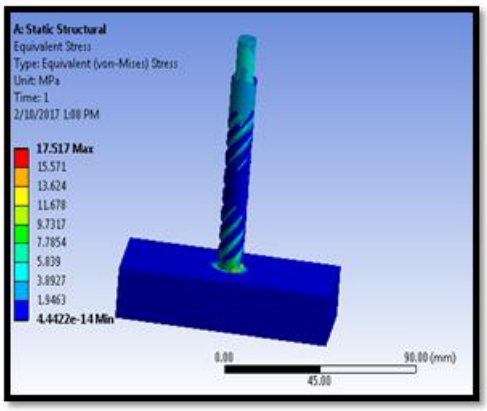


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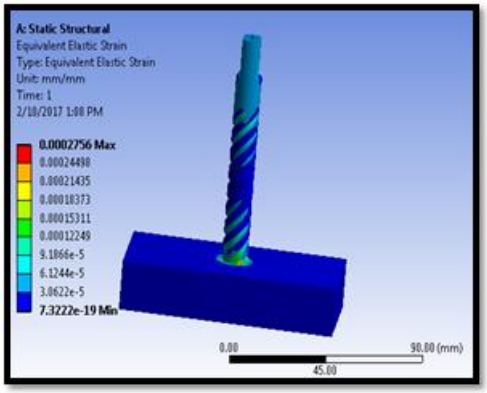
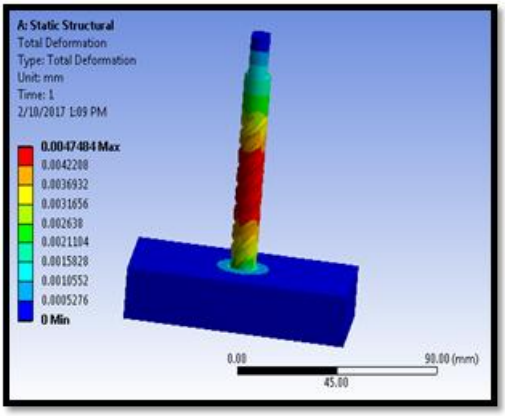



## MATERIAL –TITANIUM ALLOY
## FORCE – 2100 N

## TOTAL DEFORMATION



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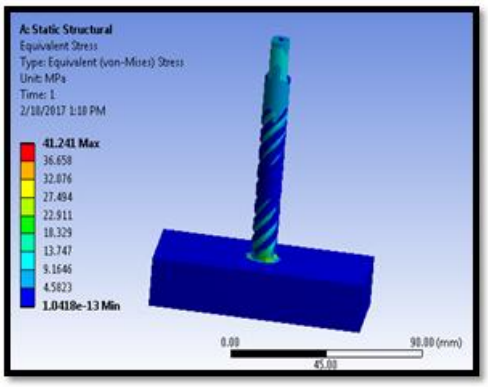


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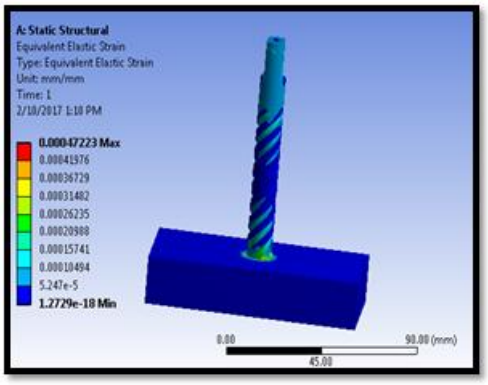
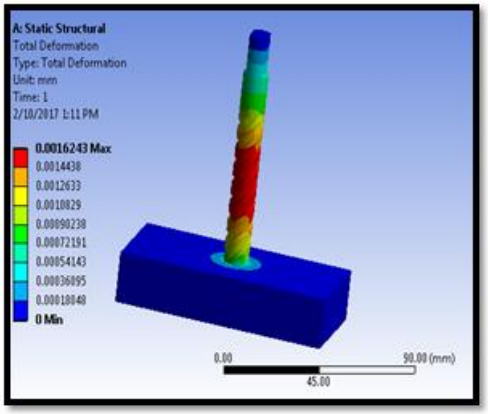



**MATERIAL –E GLASS EPOXY**
**FORCE –624 N**

**TOTAL DEFORMATION**

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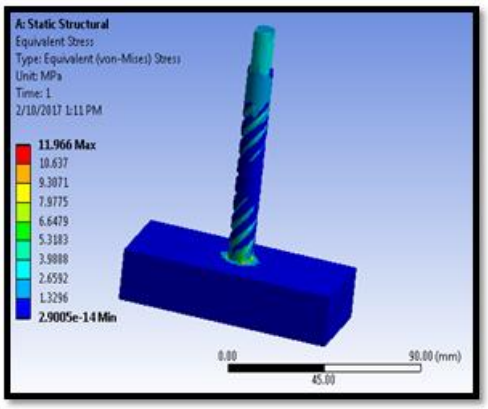


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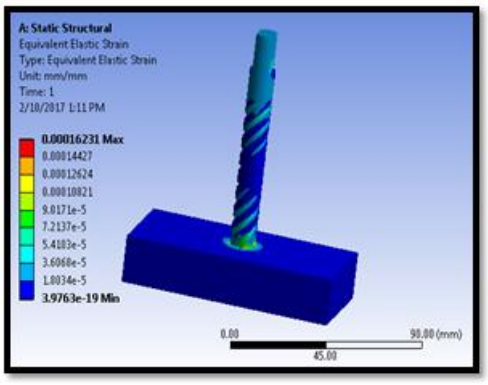
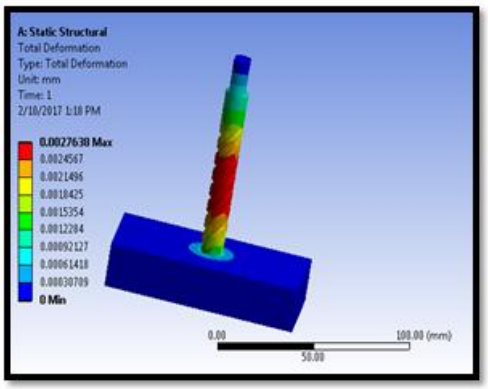



**12 MM DIAMETER - $120^0$ ANGLE**
**MATERIAL –ALUMINUM**
**FORCE – 900 N**

**TOTAL DEFORMATION**



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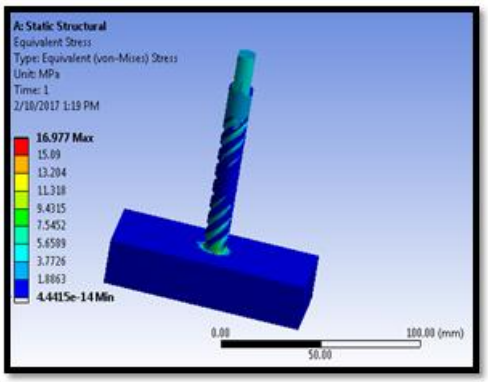


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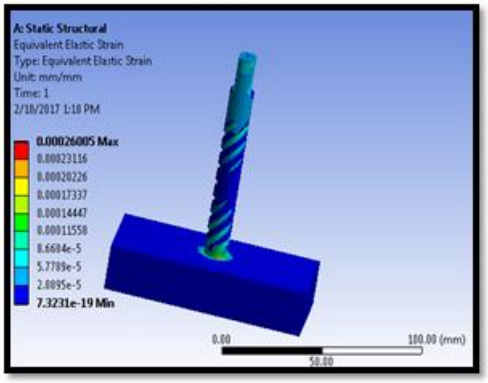
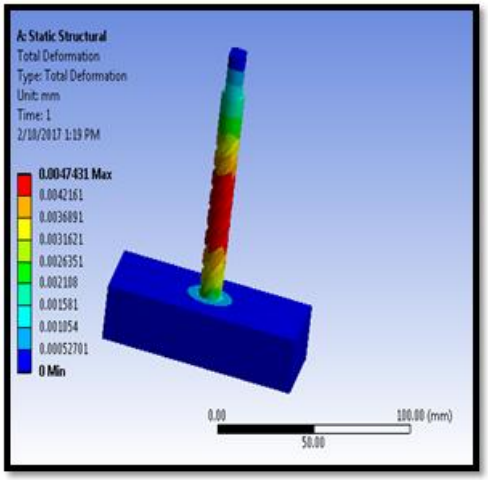



**MATERIAL –TITANIUM ALLOY**
**FORCE – 2100 N**

**TOTAL DEFORMATION**

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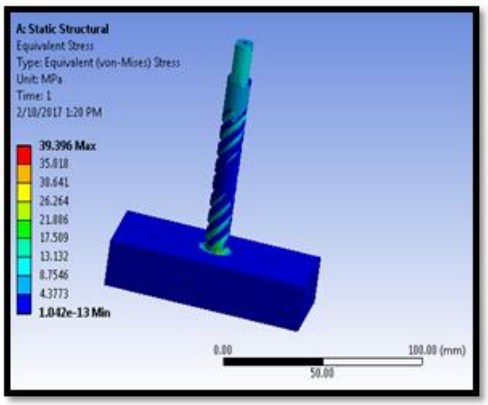


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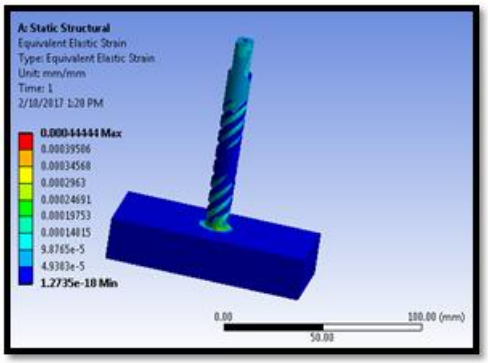
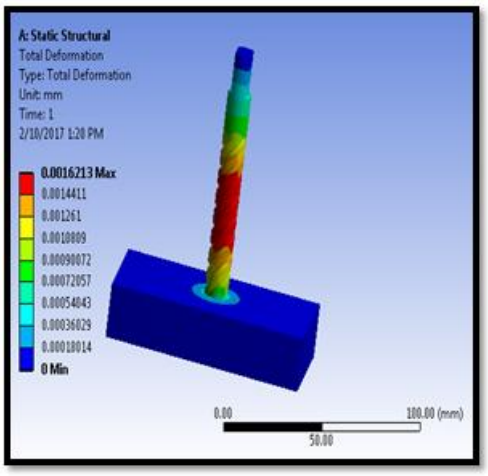



**MATERIAL –E GLASS EPOXY**
**FORCE – 624 N**

**TOTAL DEFORMATION**



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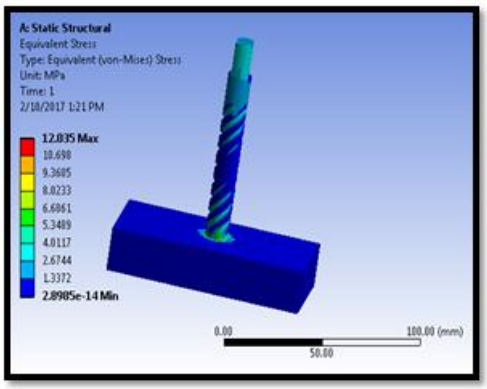
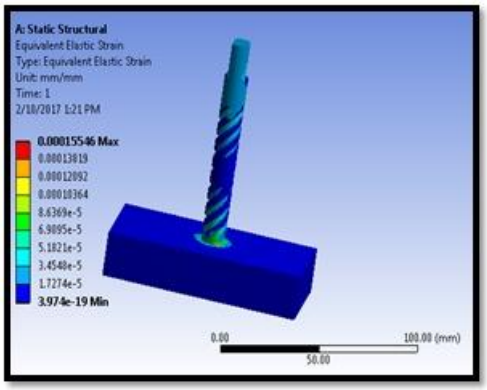
## STRESS




## STRAIN



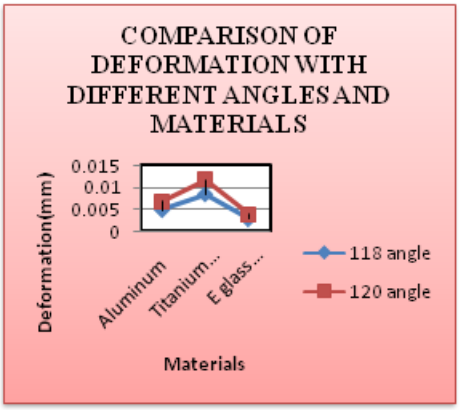

## RESULTS &DISCUSSION

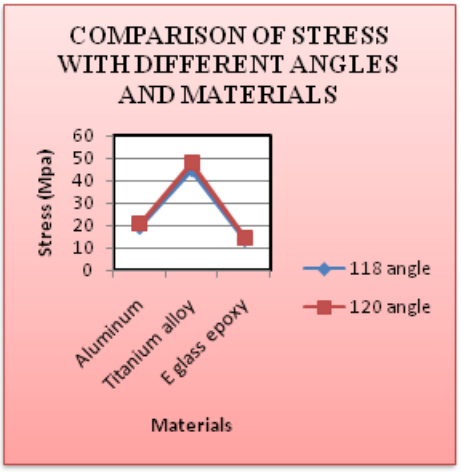
## STRUCTURAL ANALYSIS

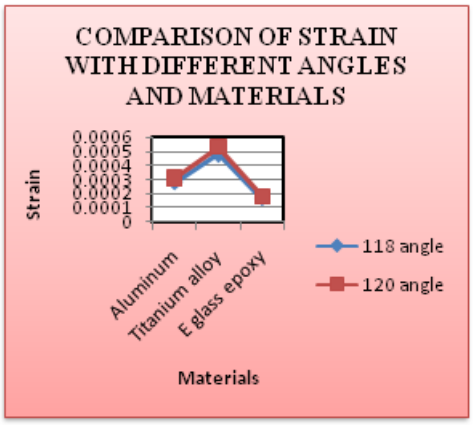
### 8 mm DIAMETER

| Angles | Materials | Total deformation (mm) | Stress (MPa) | Strain |
|---|---|---|---|---|
| $118^0$ | Aluminium | 0.0049176 | 19.497 | 0.000280 62 |
| | Titanium alloy | 0.0084656 | 45.006 | 0.000478 66 |
| | E glass epoxy | 0.0028551 | 13.916 | 0.000167 78 |
| $120^0$ | Aluminium | 0.0068363 | 20.565 | 0.000306 73 |
| | Titanium alloy | 0.011782 | 47.786 | 0.000526 23 |
| | E glass epoxy | 0.0039531 | 14.457 | 0.000181 1 |

## GRAPHS



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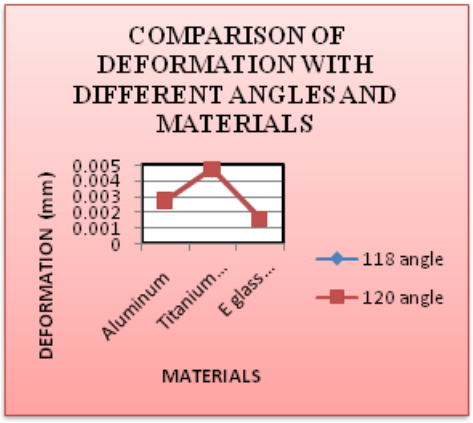
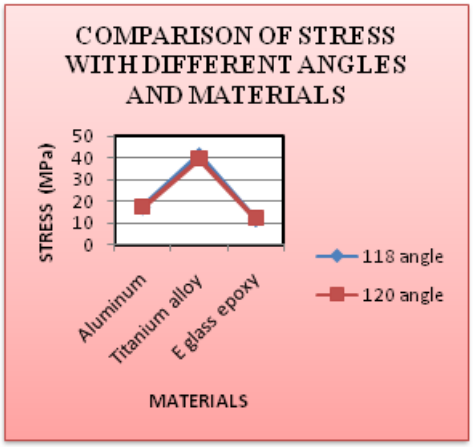
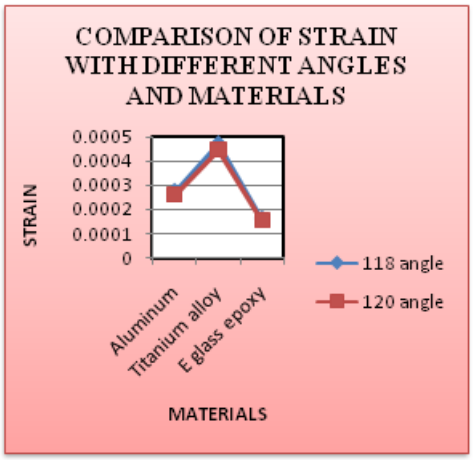
### 12 mm DIAMETER

| Angles | Materials | Total deformation (mm) | Stress (MPa) | Strain |
|---|---|---|---|---|
| $118^0$ | Aluminium | 0.0027672 | 17.517 | 0.0002756 |
| | Titanium alloy | 0.0047484 | 41.241 | 0.00047223 |
| | E glass epoxy | 0.0016243 | 11.966 | 0.00016231 |
| $120^0$ | Aluminium | 0.0027638 | 16.977 | 0.00026005 |
| | Titanium alloy | 0.0047431 | 39.396 | 0.0004444 |
| | E glass epoxy | 0.0016213 | 12.035 | 0.00015546 |

### GRAPHS




### CONCLUSION:

In this thesis, drilling operations are conducted on the carbon fiber reinforced pieces with 12mm and 8mm diameter drills with $118^0$ and $120^0$ point angles with different cutting parameters. The cutting parameters are spindle speed – 1000rpm and 2500rpm, Feed – 0.2mm/rev for 8mm drill tool and 0.35mm/rev for 12mm drill tool. Cutting tool material is HSS. Forces are calculated using theoretical calculations. 3D modeling is done in Creo 2.0 and analysis is done in Ansys. Analysis is performed and the stresses, displacements are compared for three materials Aluminum, Titanium alloy and E Glass Epoxy. By observing the analysis results, the stresses and displacements are less for E Glass Epoxy than Aluminum and Titanium alloy. When compared the results between $118^0$ and $120^0$, the deformation and stress values are less when $120^0$ cutting tool is used.

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## AUTHORS:

**SVY Sastry** received the B.Tech degree in Mechanical Engineering from National Institute of Technology, Jalandhar, Punjab, India, in year 2004, and is pursuing M.Tech in CAD-CAM from Kakinada Institute of Technology and science, Divili, Andhra Pradesh, India.

**Sri., AV Sridhar** M.Tech, Associate professor, Kakinada Institute of Technology &Science, Divili , Andhra Pradesh, India.

**Sri.S.Rajasekhar** M.Tech, (Ph.D), Associate professor, Kakinada Institute of Technology &science, Divili, Andhra Pradesh, India.