# DESIGN AND STRUCTURAL ANALYSIS FOR BASE STRUCTURE OF DUAL CUTTING HEAD PCB DRILLING MACHINE

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***Abstract – Drilling Machines is used to make a hole and it is widely used in industry. Other processes for producing holes are punching and various advanced machining processes. The cost of holes making is one of the highest machining costs. There are several types of drilling which are gun drilling, twist drill, and trepanning. The most common drill is the conventional twist drill. Many products used drilling as their major processes. Without drilling operation, the work cannot be done successfully. Drilling operation has been used in many sectors of industries such as automotive, piping, major industries also minor industries. The importance of drilling is increase by time because of the modern world and the used of high speed product in our life.***
***Drilling operation also used in electronic industries. One of the examples is to produce a hole on a circuit board. Even as tiny as a ants, it also need to use drilling operation. That show us how important is drilling operation.***
***The main objective of research paper is to reduce vibration of frame structure of PCB drilling machine. By applying propose material selection for structure and optimize dimension of structure from data of present PCB drilling machine and change geometry and material of structure.***

***Index Terms – PCB Drilling Machine, Structure, Vibration, Material, Modeling, Analysis.***

## I. INTRODUCTION

Micro drilling process is used to produce a small highly accurate hole which is a common requirement across large number of industries and applications. Industries and applications that require huge volumetric production, the drilling time and the finishing of the hole, rivals the cost of the process. So an intensive study of the machining process is required to make the production economical. Drilling refers to a metal removal process which removes a circular cross section from the work piece. The drill bit which is a multipoint cutting tool in most cases is pressed against the material and rotated which cuts of chip from the material and this result in the formation of hole. Drilled holes are characterized by their sharp edge on the entrance side and the presence of burrs on the exit side. Helical feed marks are also present inside the hole. Drilling also affects the mechanical properties of the material. So in order to find out the local circularity error, the use of optical microscope (SEM) is required. The forces acting during the operation is measured using dynamometer. The work piece used is copper coated PCB. Drilling operation is performed on a CNC machine by coding an appropriate program. The drill bit used in this case has a diameter of 1 mm. The burr formed during the drilling operation must also be examined and analyzed in order to reduce it in future operation.

## II. PCB DRILL MECH SS300

**Fig.1 PCB Drill Mech SS300**

Aditi Engineering Works introduces PCB Drill Mech SS300 of fully intergraded intelligent PCB Drill system. The PCB Drill Mech SS300 is unique in its combination of Speed, Accuracy, Simplicity and Reliability. PCB Drill Mech SS300 offers the latest in PCB Drilling Systems at cost effective price.

**SYSTEM FEATURES**

1. Rigid machined main structure with high precision assembly provides stable structure, good shock absorption, smooth running and high rigidity, assuring high precision.
2. Adopt imported ball screw and Linear Motion guide.
3. 400W Fuji Servo Motor-Made in Japan
4. PC based Software-PCB Mech Drill 12
5. 800W spindle and 24000 RPM.
6. Gerber file support.
7. Data path optimization.

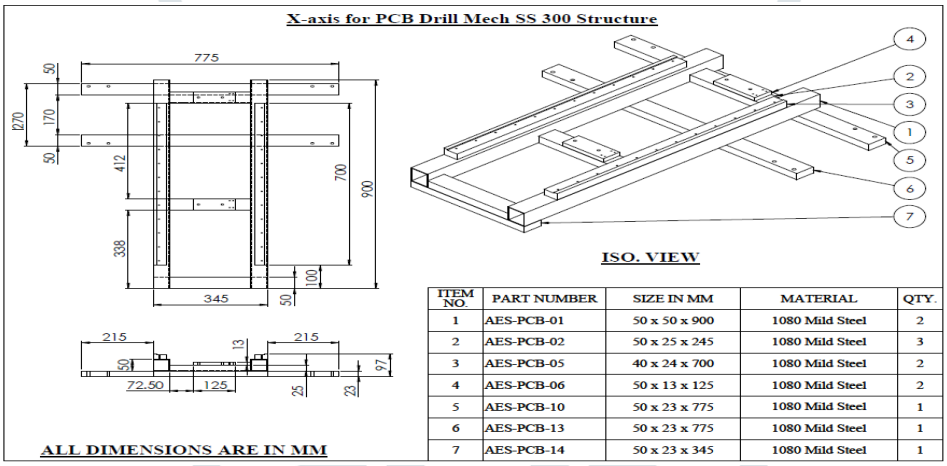
**TECHNICAL DATA**

**Table 1 Technical Data**

| Sr. No. | Model | PCN Drill Mech SS300 |
|---|---|---|
| 1 | Working Area | 300mm x 300mm |
| 2 | Working Table | 340mm x 340mm x 70mm |
| 3 | Accuracy | < 0.015mm |
| 4 | Repeatability | 0.003 mm |
| 5 | Drill Per Minute | 90 drill 8 mm stock (Single Spindle) |
| 6 | No of Spindle | 1 |
| 7 | Spindle Power | 800 W |
| 8 | Spindle RPM | 24000 RPM |
| 9 | Rapid Speed (Working) | 15 m/min |
| 10 | Total Power | 15 kV |
| 11 | Motor and Drive | Fuji Servo- Made in Japan |
| 12 | Power Supply input | 230V |
| 13 | Machine size | 800 x 800 x 900 MM |
| 14 | Packing size | 900 x 900 x 1000 MM |

## III. CAD MODELING AND FEA ANALYSIS OF PCB DRILL MECH SS300 STRUCTURE

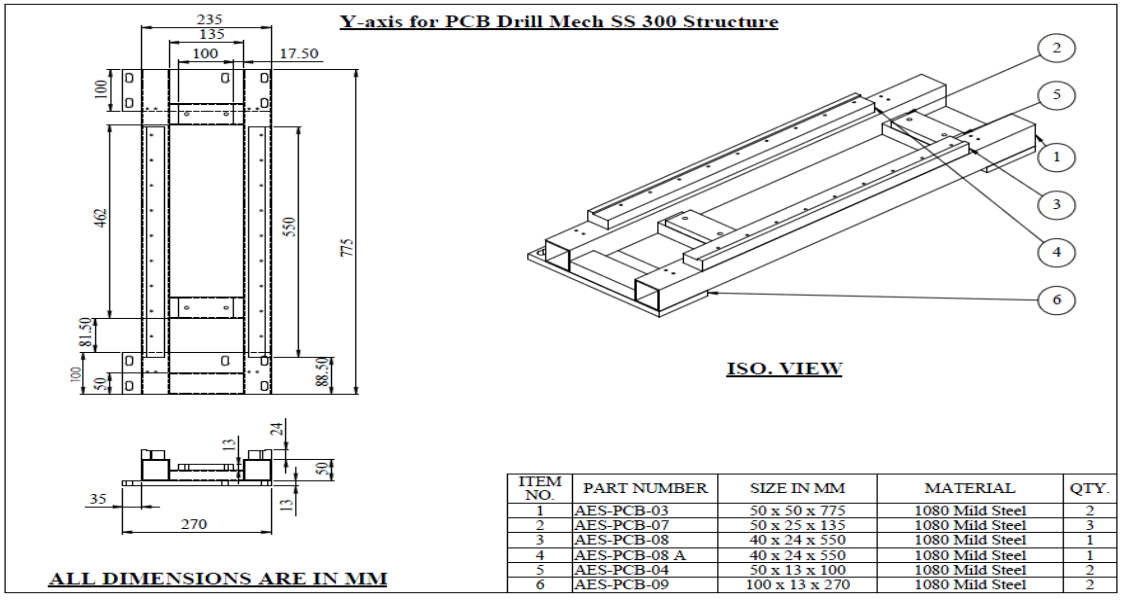
Turn off visibility of nonessential components. Access the parts we need and update graphics faster. Use design representations. Create design representations that highlight specific design problems or assembly subsystems, and apply them when opening the assembly model. Turn off part adaptivity. After we size components, turn off adaptivity to speed up solutions and prevent accidental changes. Assign different colors to components. Select colors from the Color list on the Standard toolbar. Use the browser to find components. Point to component in the browser to highlight in the graphics window.Use color to identify components groups. Using attributes, find components in specific subsystems or from specific vendors and color-code them in named representations.




| ITEM NO. | PART NUMBER | SIZE IN MM | MATERIAL | QTY. |
|---|---|---|---|---|
| 1 | AES-PCB-01 | 50 x 50 x 900 | 1080 Mild Steel | 2 |
| 2 | AES-PCB-02 | 50 x 25 x 245 | 1080 Mild Steel | 3 |
| 3 | AES-PCB-05 | 40 x 24 x 700 | 1080 Mild Steel | 2 |
| 4 | AES-PCB-06 | 50 x 13 x 125 | 1080 Mild Steel | 2 |
| 5 | AES-PCB-10 | 50 x 23 x 775 | 1080 Mild Steel | 1 |
| 6 | AES-PCB-13 | 50 x 23 x 775 | 1080 Mild Steel | 1 |
| 7 | AES-PCB-14 | 50 x 23 x 345 | 1080 Mild Steel | 1 |

**Fig.2 Detail view drawing X-axis of PCB Drill Mech SS 300 Structure**

The structures of PCN Drill Mech SS 300 is divided in to two part one for X-axis which axis for work piece like PCB and another for Y-axis for movement of Z-axis which having a spindle or tool for 2 D hole cutting.




| ITEM NO. | PART NUMBER | SIZE IN MM | MATERIAL | QTY. |
|---|---|---|---|---|
| 1 | AES-PCB-03 | 50 x 50 x 775 | 1080 Mild Steel | 2 |
| 2 | AES-PCB-07 | 50 x 25 x 135 | 1080 Mild Steel | 3 |
| 3 | AES-PCB-08 | 40 x 24 x 550 | 1080 Mild Steel | 1 |
| 4 | AES-PCB-08 A | 40 x 24 x 550 | 1080 Mild Steel | 1 |
| 5 | AES-PCB-04 | 50 x 13 x 100 | 1080 Mild Steel | 2 |
| 6 | AES-PCB-09 | 100 x 13 x 270 | 1080 Mild Steel | 2 |

**Fig.3 Detail view drawing Y-axis of PCB Drill Mech SS 300 Structure**

Fig.2 and 3 are reflected detail drawing of both structure of X and Y axis respectively. Using part features creates all components of structure. All assemblies are created using various components (part) by constrained there relative motion. Using part modeling environment to create structure.

First to make geometry of standard section pipe with respect their practical data to measure thickness of plate and amount of extruded part by using extrude command in feature operation.

Further using new sketch on base extruded component and draw sketch on existing extruded feature to identifying model width.

As shown in Figure 4 to 7, there are different orientations of PCB Drill Mech SS 300 Structure such as isometric view, front view, top view and side view.

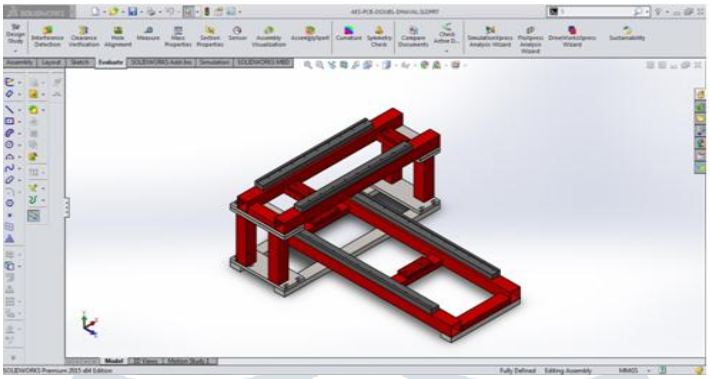


**Fig.4 Isometric view of PCB Drill Mech SS 300 Structure**

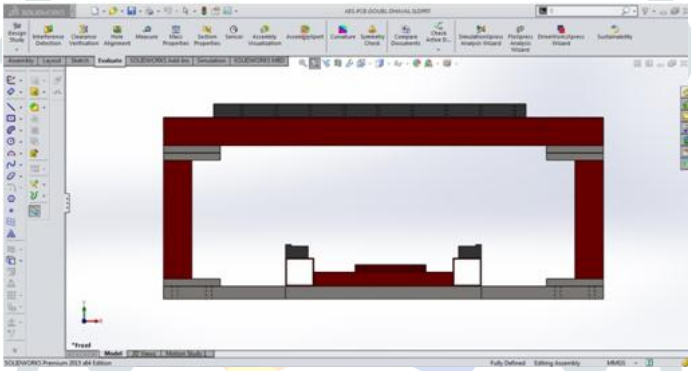


**Fig.5 Front view of PCB Drill Mech SS 300 Structure**

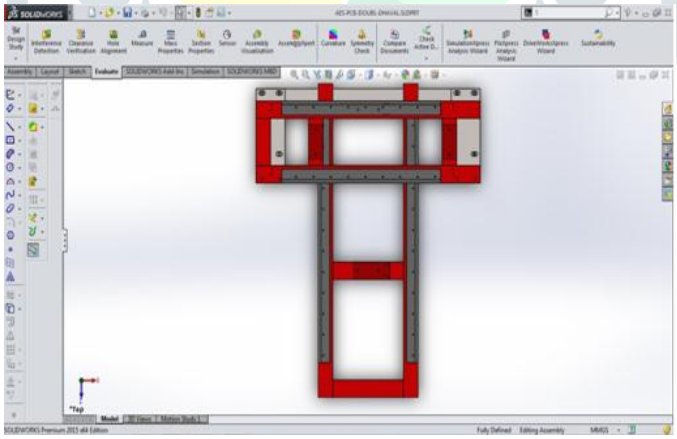


**Fig.6 Top view of PCB Drill Mech SS 300 Structure**

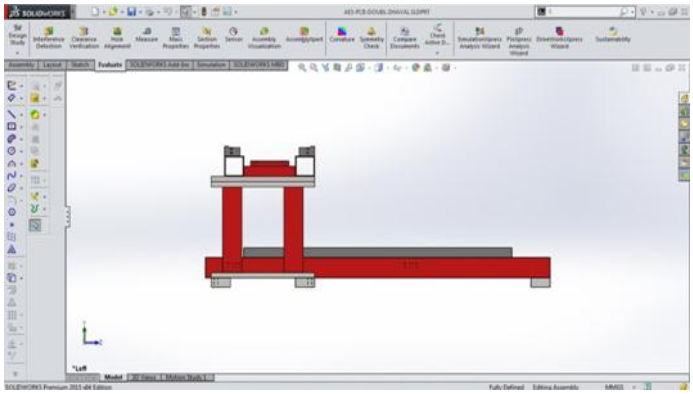


**Fig.7 Side view of PCB Drill Mech SS 300 Structure**

**STRUCTURAL ANALYSIS OF PCB DRILL MECH SS 300 STRUCTURE**

**Step-1 Pre-processing**

**1)** First Prepare Assembly in Solidworks 2015.

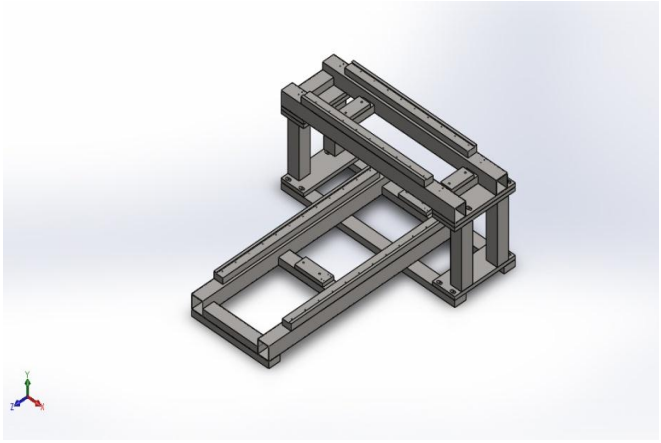


**Fig. 8 Geometry of PCB Drill Mech SS 300 Structure using static analysis**

**2)** Check the Geometry for Meshing.

**3)** Apply Material for Each Component.

**Table 2 1080 Mild Steel Material Properties**

| Structure | Material used | Young Modulus (Gpa) | Yield Strength (Mpa) | Poisions Ratio | Density ($Kg/m^3$) |
|---|---|---|---|---|---|
| PCB Drill Mech SS 300 Structure | 1080 Mild Steel | 210 | 550 | 0.266 | 7860 |

**4)** Create mesh.

Solid mesh (Jacobian Point : 4 Point) which is programme generated.
Fine Meshing is apply
No. of Nodes:- 150067
No. of Elements:- 91257

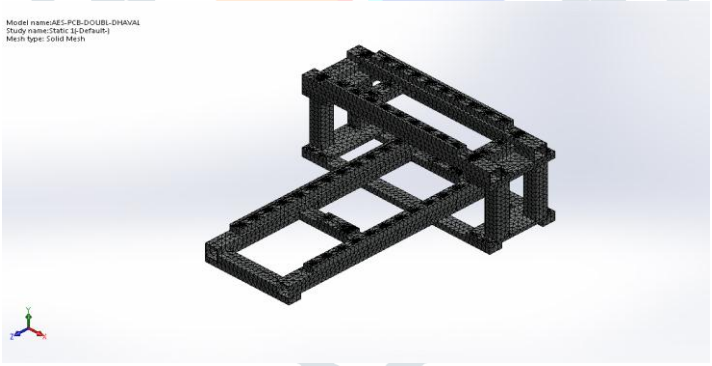


**Fig. 9 Meshing of PCB Drill Mech SS 300 Structure using static analysis**

**5) Define Boundry condition**

Apply Fixed Support at bottom edge and Remote Displacement at top end. In fixed support boundary condition, bottom face of structure having not movement along X,Y & Z and also rotation same axis.

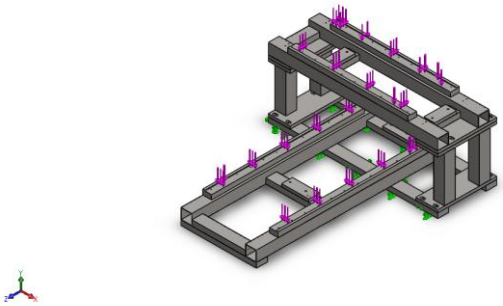


**Fig. 10 Boundary condition of Sw PCB Drill Mech SS 300 Structure using static analysis**

**Apply Force**

Force magnitude on swing X-axis is 270N.
Force magnitude on swing Y-axis is 350N.

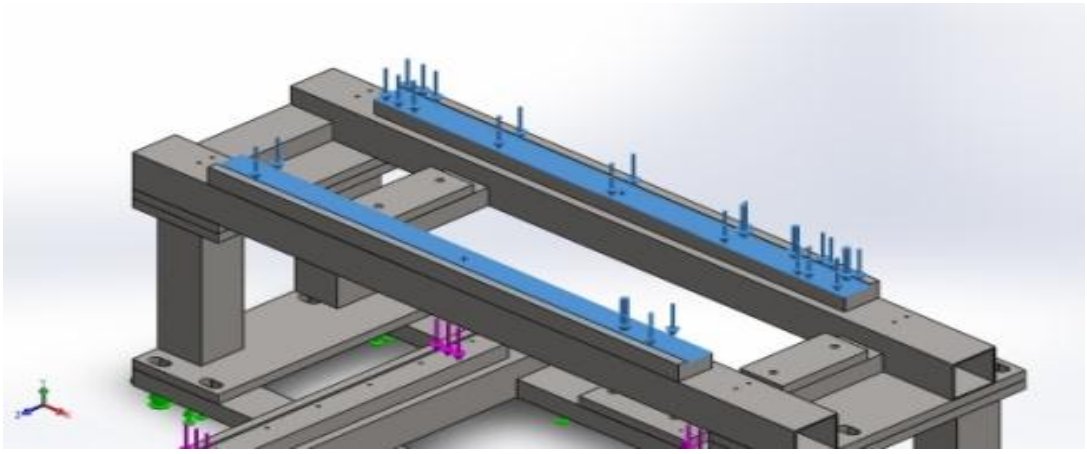


**Fig.11 Force applying on X axis of PCB Drill Mech SS 300 Structure**

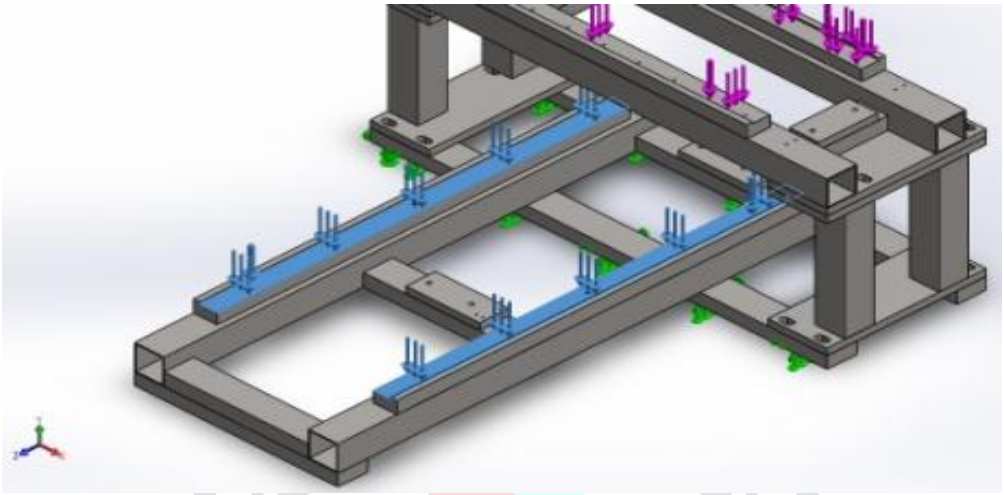
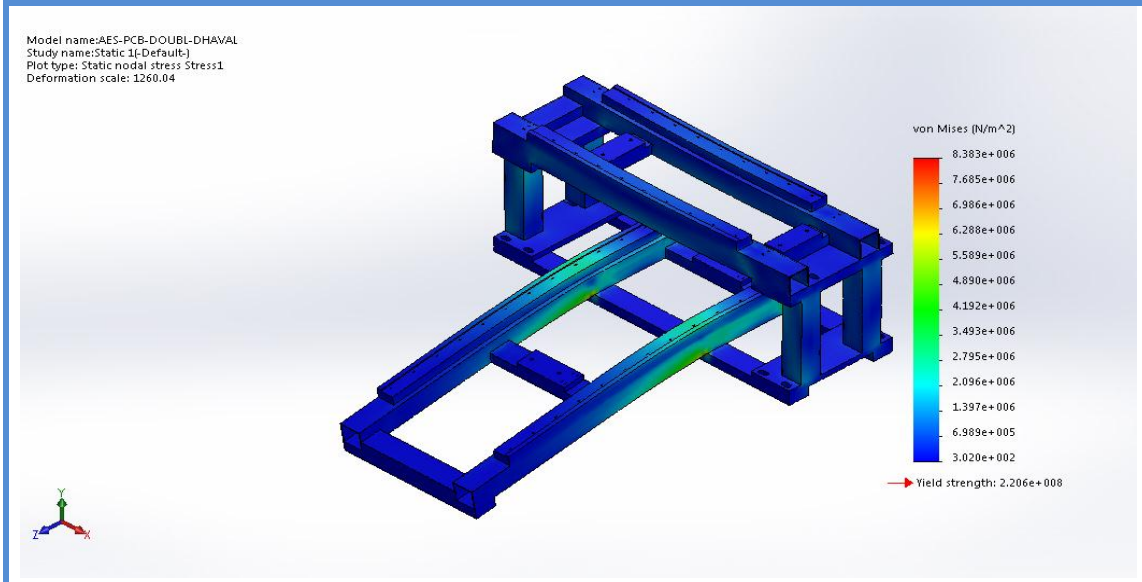


**Fig.12 Force applying on Y axis of PCB Drill Mech SS 300 Structure**

**Results of Analysis**

**Equivalent Stress for static analysis**

| Name | Type | Min | Max |
|---|---|---|---|
| Stress1 | VON: von Mises Stress | 302.045 N/m^2<br>Node: 73617 | 8.38338e+006 N/m^2<br>Node: 21602 |



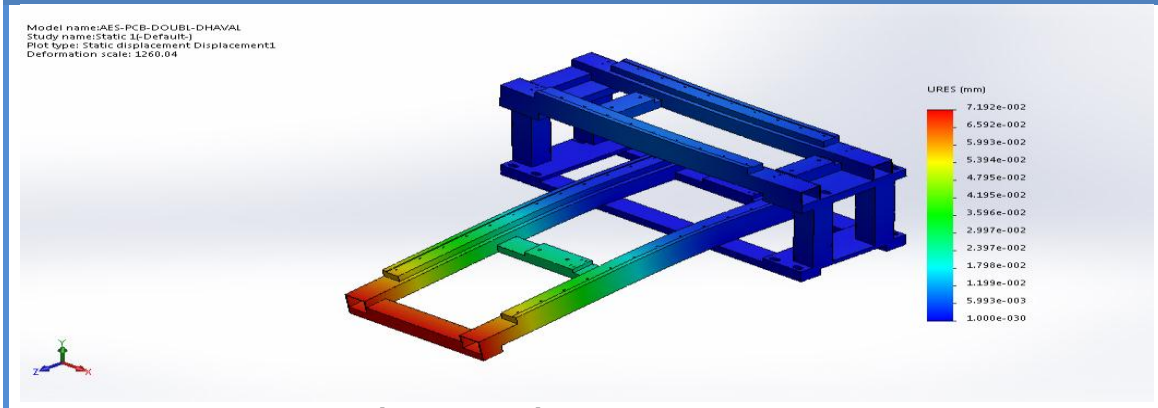

AES-PCB-DOUBL-Static 1-Stress-Stress1

**Fig.13 Equivalent Stress analysis of PCB Drill Mech SS 300 Structure**

**Displacement**

| Name | Type | Min | Max |
|---|---|---|---|
| Displacement1 | URES: Resultant Displacement | 0 mm<br>Node: 67138 | 0.0719179 mm<br>Node: 76716 |

| Name | Type | Min | Max |
|---|---|---|---|

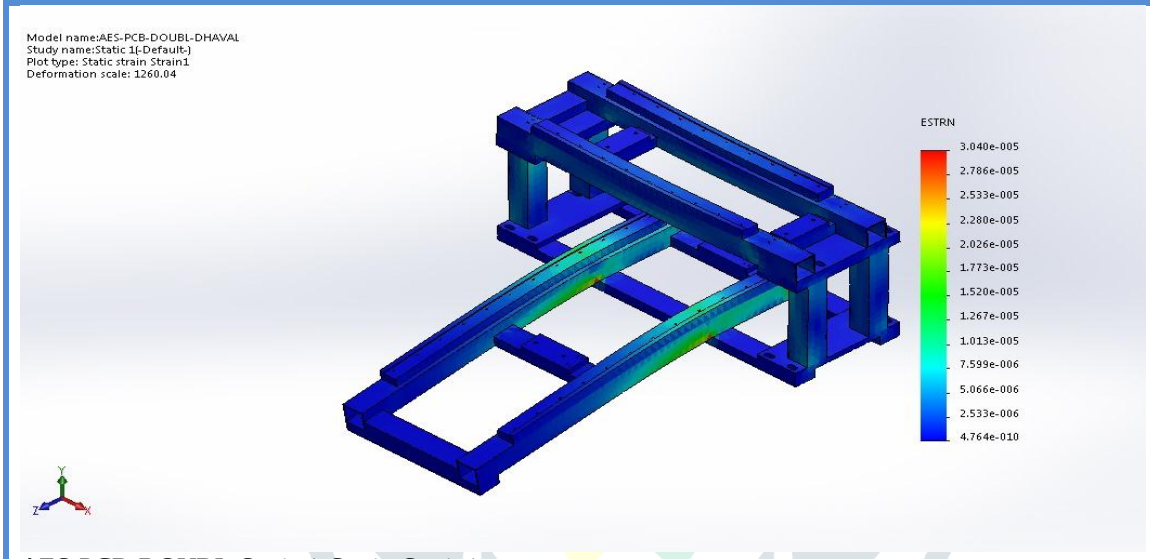



AES-PCB-DOUBL-Static 1-Displacement-Displacement1

**Fig.14 Displacement of PCB Drill Mech SS 300 Structure**

**Equivalent Strain**

| Name | Type | Min | Max |
|---|---|---|---|
| Strain1 | ESTRN: Equivalent Strain | 4.76439e-010<br>Element: 13195 | 3.03962e-005<br>Element: 542 |




AES-PCB-DOUBL-Static 1-Strain-Strain1

**Fig.15 Equivalent Stress analysis of PCB Drill Mech SS 300 Structure**

**Table 3 Result**

| Material | Von mises stress ($N/m^2$) | Strain | Displacement(mm) |
|---|---|---|---|
| 1080 Mild Steel | $8.383 \times 10^6$ | $3.039 \times 10^{-5}$ | 0.0719 |

**IV. ACKNOWLEDGMENT**

It is indeed a great pleasure for me to express my sincere gratitude to those who have always helped me for this dissertation work. I am extremely thankful to my thesis guide Asst. Prof. Dhaval P Patel, Asst. professor in Mechanical Engineering Department, Gandhinagar Institute of Technology, Moti Bhoyan is valuable guidance, motivation, cooperation, constant support with encouraging attitude at all stages of my work. I am highly obliged to him for his constructive criticism and valuable suggestions, which helped me to present the scientific results in an efficient and effective manner in this research.

**V. CONCLUSION**

By using practical data of PCB Drill Mech SS 300 structure, prepared 3D CAD model for Finite Element Analysis in Solid Works 2015. From analysis result find value of von mises stress, strain and displacement (deflection) for optimize structure in strength and cost.

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