

Design and Analysis of Sheet Metal Die Punch

Suvarna Babu. R, Mr. Bhojendra Naik M

Assistant Professor

Department of Mechanical Engineering

St. Martin's Engineering College, Dhulapally, Secunderabad, Telangana State

Corresponding Author's email id: rsuvarnabau@gmail.com, bhojnaik@gmail.com

Abstract

The sheet metal working processes are widely used in almost all industries like automotive, defense, medical and mechanical industries. The major advantage for using metal working process is to improve production rate and to reduce the cost per piece. Nowadays many people are working for developing die punches with innovative ideas. This project is also based on new design for die punch.

The project mainly focuses on different operations done on single setup of die punch in a single stroke; presently these operations are done on three separate setups which leading to reduce the production rate and increasing cycle time. With cost as well. The 3D parts are modeled in solid works and saved in .stp file format so that it can be imported from any of the analysis software. As per the companies requirement cad drawings are drawn in solid works software.

The various analyses like Von-Mises stress analysis are carried out on solid works simulation analysis software. By observing the results for 15ton load the punch and die are within the safe limits i.e., less than the material yield strength. But for the 20tonn load the punch is within the safe limit where as die has yielded more stresses than material yield strength. So 15ton load is safe operated for punch and die.

Keywords: - *Metal Die Punch, Von- Mises stress analysis, Punching, 3D Parts*

INTRODUCTION

In punching, press shearing is the procedure of cutting metal plate without producing the chip. The material is stressed and force applied on a metal sheet can be done by the punch and die. Shearing consist of three stages—plastic deformation, penetration and fracture. In plastic deformation, force is applied by the punch tool on the metal work piece, the force tends to deform the metal into the die opening then the elastic limit increases with the increase in load. This stage starts to transform the metal in a radius form on the lower edge called plastic deformation of material. In penetration, load further increases and the punch starts to penetrate the material to a certain depth and starts to force the metal or material of sheet into the die portion; this stage consists of a bright surface finish on both the strips and the blank. This stage is called penetration stage. In fracture stage, when load increases on material beyond the plastic limit the material starts fracturing from both the upper and lower cutting edges and the load on the punch increases continuously, the fracture extends and causes complete separation. Press can be classified according to frame, delivering power mechanism, working area size, number of stations utilized for heavy production and mass production. The sheet

metal operation in punching press is divided into two parts—cutting operations and forming operations. In cutting operations the metal work piece is stressed up to ultimate strength point and the shear stresses develops into the metal sheet while forming operations are used to change the shape of metal sheet as per the requirement with the help of force applied on the metal due to which stress is developed below the ultimate strength point; there is no cutting of metal in whole operation only the surface profile of the work piece is changed to get the product shape. Cutting operations include process such as blanking, punching, notching, perforating, trimming, shaving, slitting and lancing. Forming in this operation includes process such as bending, drawing and squeezing.

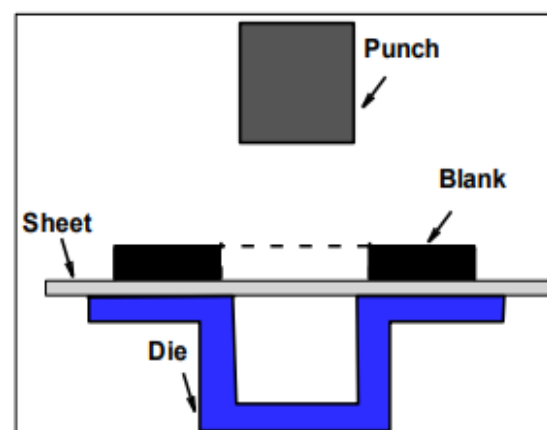


Fig 1: Punching press operation layout

Figure 1 shows the components of a punching operation. It includes parts such as, punch which applies the force and is in motion, sheet on which load is being applied, blank die which gives the shape to the sheet and blank holder which holds the sheet in position. Naik and Mandavgade [1] in the year 2012 studied the effect of finite element analysis (FEA) implementation in hydraulic cotton lint bailing machine for optimization of top and bottom frame. They targeted their study towards reducing the bending stresses, reducing the cost, increasing the safety and to design the process successfully into a structural shape optimization problem. They used topology for optimization of the problem by taking the weight as an objective function. Software ANSYS was used for this work and found 13% reduction in frame. Chauhan and Bambhania [2] in the year 2013 designed and analyzed frame of a 63 tons power press machine using finite element method of an industry. Material used by them were ST 42 W, which have a maximum tensile strength of 540MPa, maximum allowable stress of 105Mpa, Young's modulus of 2100 GPA and density of 7850 kg/m³. They utilized CAD for modeling of the geometry and imported it in the FEA software and found

that thickness of the machine can be reduced by 25%.

Punching is a forming process that uses a punch press to force a tool, called a punch, through the work piece to create a hole via shearing. Punching is applicable to a wide variety of materials that come in sheet form, including sheet metal, paper, vulcanized fiber and some forms of plastic sheet. The punch often passes through the work into a die. A scrap slug from the hole is deposited into the die in the process. Depending on the material being punched this slug may be recycled and reused or discarded.

Punching is often the cheapest method for creating holes in sheet materials in medium to high production volumes. When a specially shaped punch is used to create multiple usable parts from a sheet of material the process is known as blanking. In metal forging applications the work is often punched while hot, and this is called hot punching. Slugging is the operation of punching in which punch is stopped as soon as the metal fracture is complete and metal is not removed but held in hole.

PROCESS:

Punch tooling (punch and die) is often made of hardened steel or tungsten carbide. A die is located on the opposite side of the work piece and supports the material around the perimeter of the hole and helps to localize the shearing forces for a cleaner edge. There is a small amount of clearance between the punch and the die to prevent the punch from sticking in the die and so less force is needed to make the hole. The amount of clearance needed depends on the thickness, with thicker materials requiring more clearance, but the clearance is always less than the thickness of the work piece. The clearance is also dependent on the hardness of the work piece. The punch press forces the punch through a work piece, producing a hole that has a diameter equivalent to the punch or slightly smaller after the punch is removed. All ductile materials stretch to some extent during punching which often causes the punch to stick in the work piece. In this case, the punch must be physically pulled back out of the hole while the work is supported from the punch side, and this process is known as stripping. The whole walls will show burnished area, rollover, and die break and must often be further processed. The slug from the hole falls through the die into some sort of container to either dispose of the slug or recycle it.

GEOMETRY:

The work piece is often the form of a sheet or roll. Materials for the work piece can vary, commonly being metals and plastics. The punch and die themselves can have a variety of shapes to create an array of different shaped holes in the work piece. Multiple punches may be used together to create a part in one step.



Fig 2: Extruded Holes

Usually, the punch and die are close to the same dimensions, creating a sheared edge when they meet. A punch that is significantly smaller than the die can be used to produce an extruded hole where the punch displaces the punched material to the sides, forming a tube perpendicular to the sides, forming a tube perpendicular to the punched sheet.

DIE FORMING:

Forming dies are typically made by tool and die makers and put into production after mounting into a press. The die is a metal block that is used for forming materials like sheet metal and plastic. For the vacuum forming of plastic sheet only a single form is used typically to form transparent plastic containers (called blister packs) for merchandise. Vacuum forming is considered a simple molding thermoforming process but uses the same principles as die forming. For the forming of sheet metal, such as automobile body parts, two parts may be used one, called the punch, performs the stretching, bending, and/or blanking operation, while another part that is called the die block

securely clamps the work piece and provides similar stretching bending, and/or blanking operation. The work piece may pass through, several stages using different tools or operations to obtain the final form. In these case of an automotive components are will usually be a shearing operation after the main forming is done and then additional crimping or rolling operations to ensure that all sharp edges are hidden and to add rigidity to the panel.

Design of Punch and Die:

The sheet metal punch and die consists of First step: Bending on right side Second step: Die in center with springs

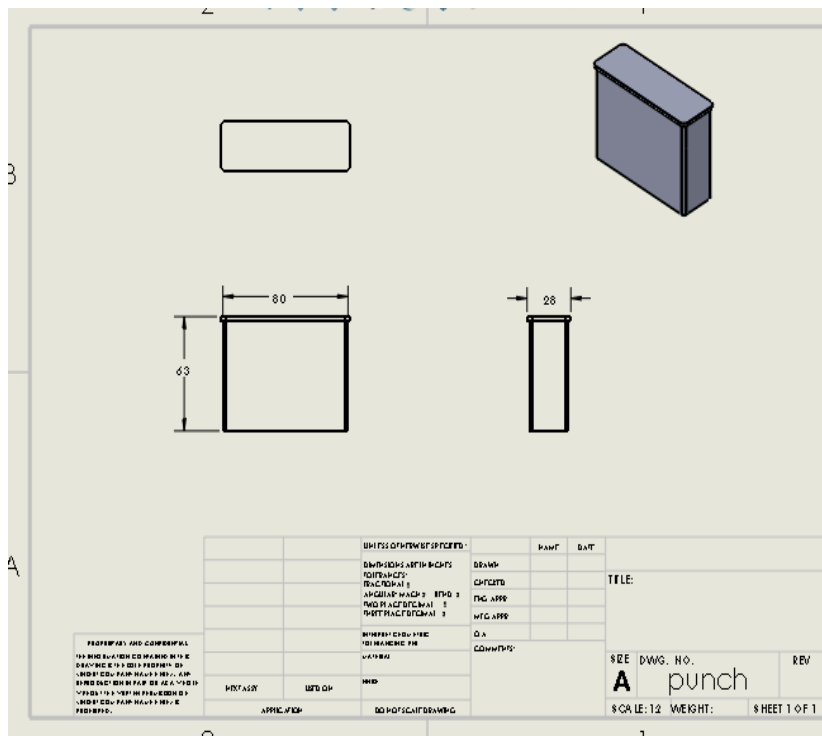


Fig 3: Punch

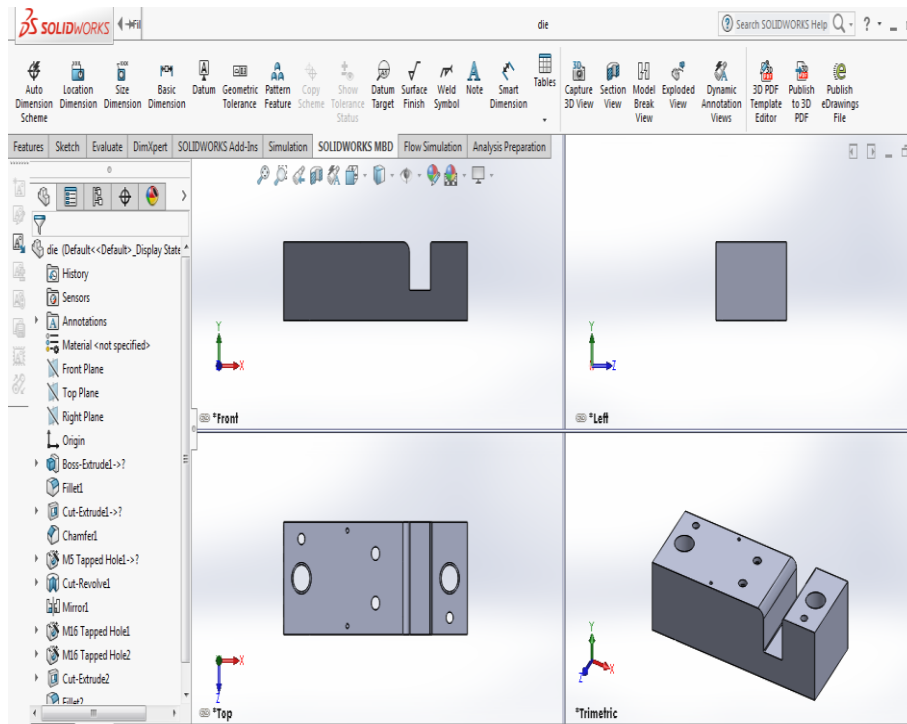


Fig 4: Different views of die

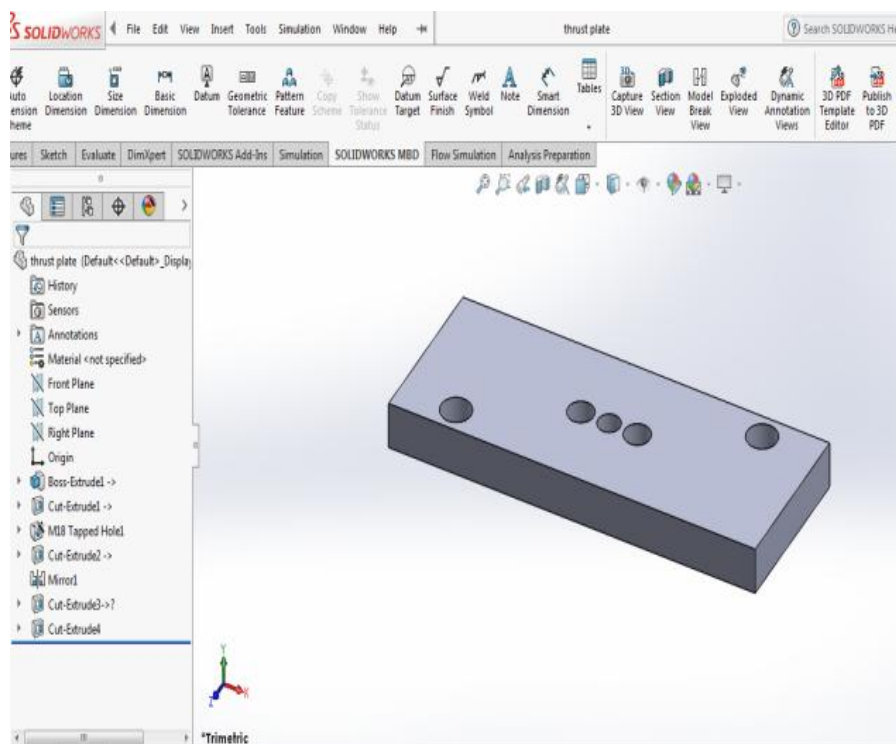


Fig 5: Thrust plate iso view

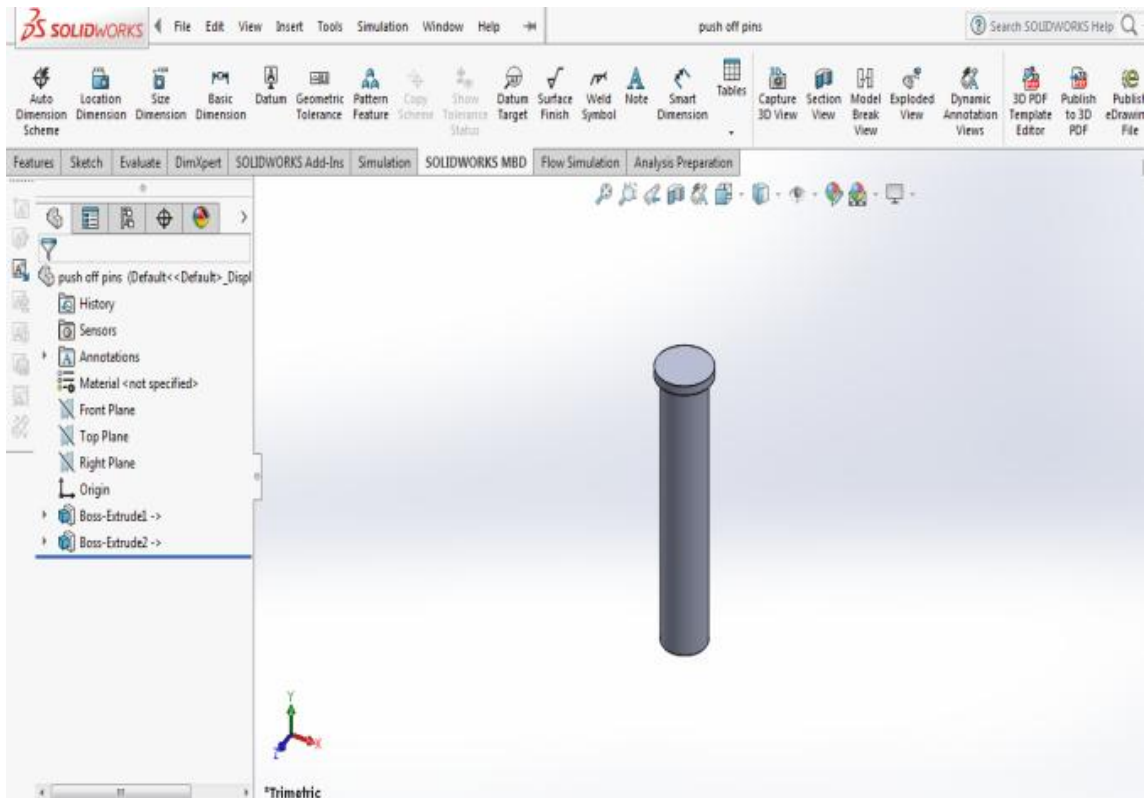


Fig 6: Push off pins

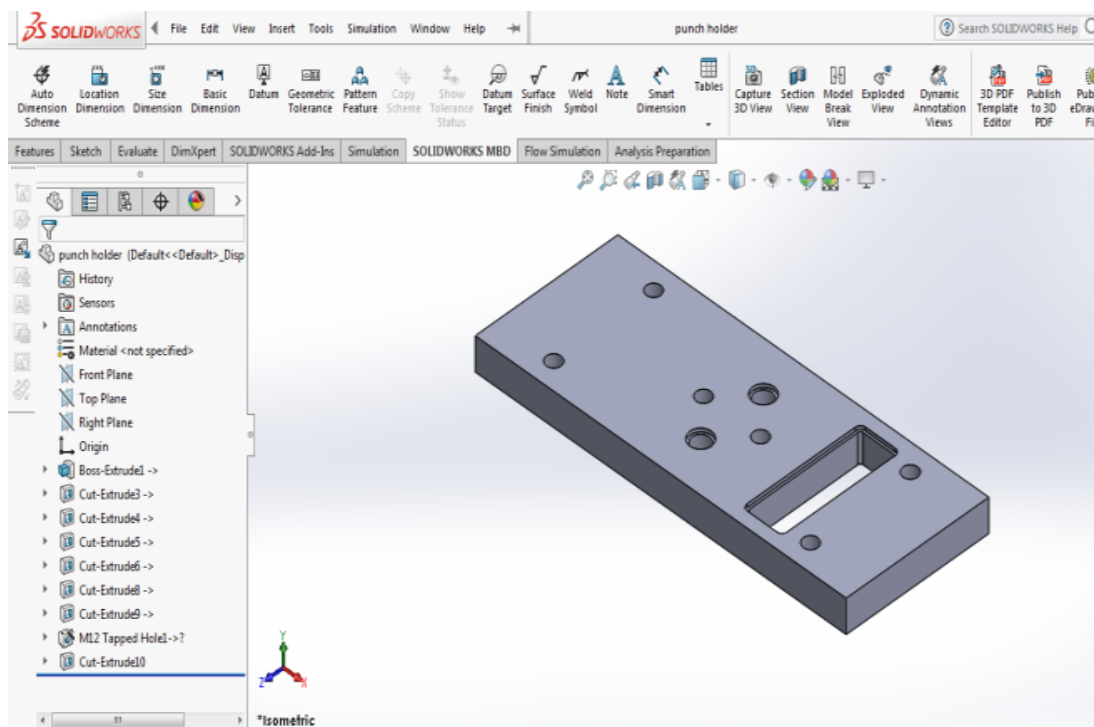


Fig 7: Punch holder iso view

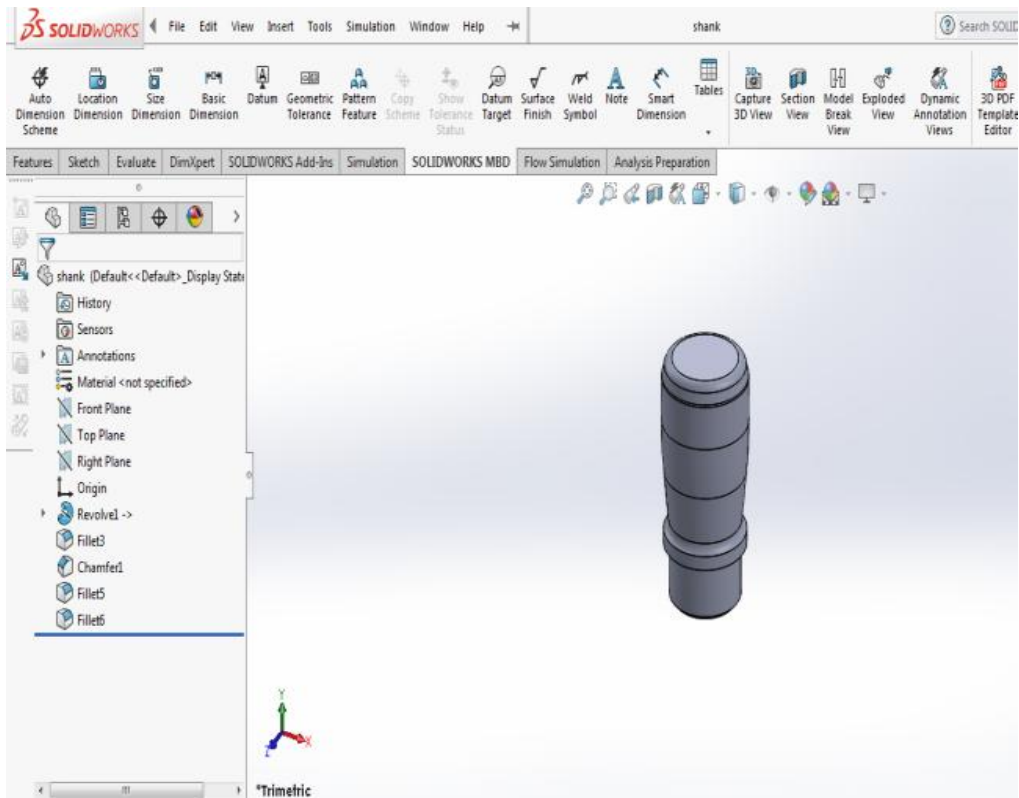


Fig 8: Shank

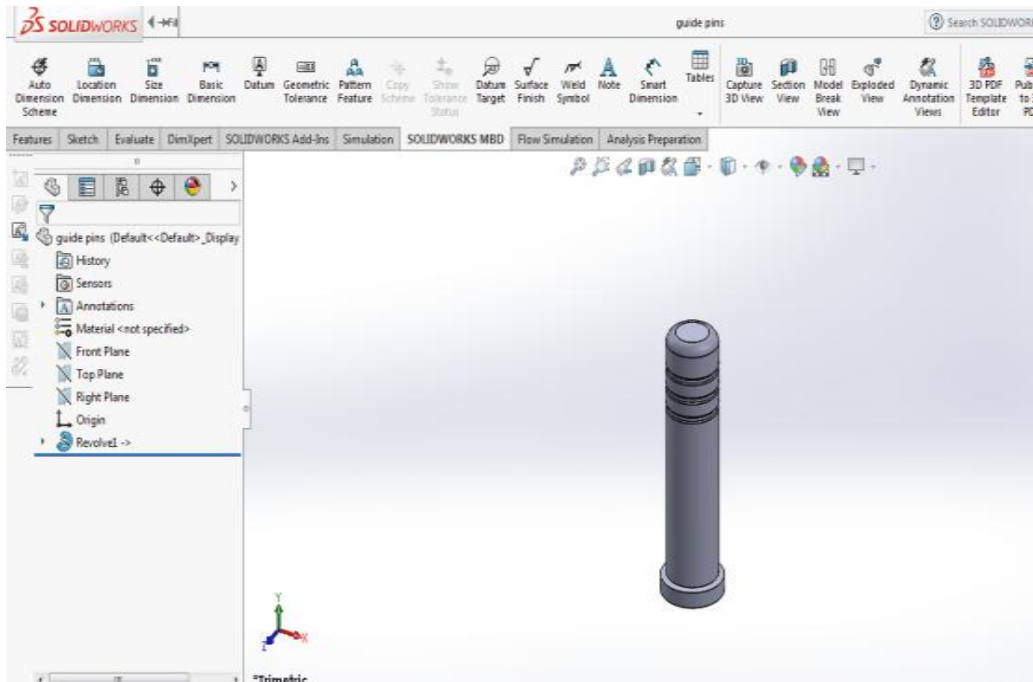


Fig 9: Guide pins

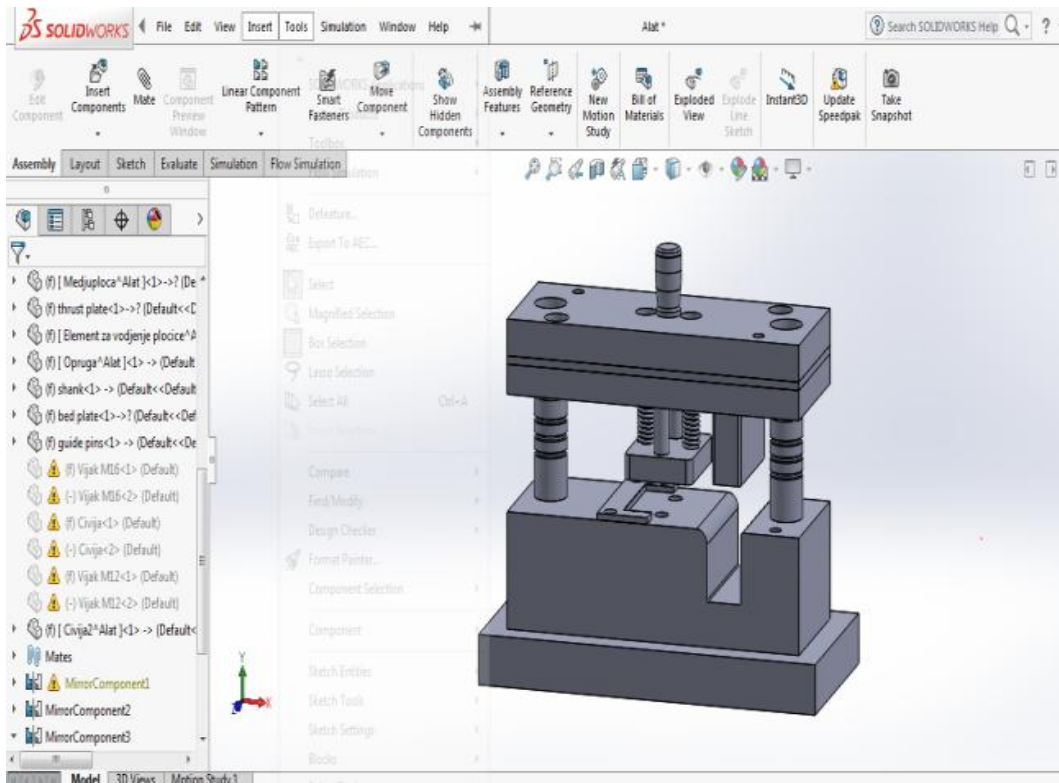


Fig 10: Assembly of Punch and Die

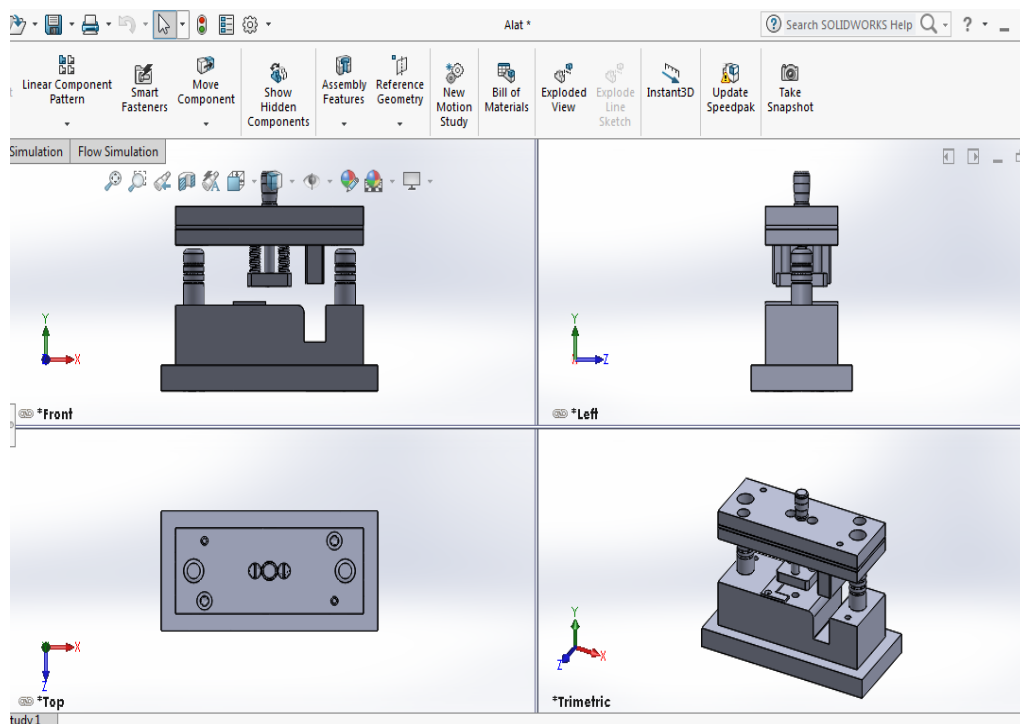


Fig 11: Diff views of punch and die

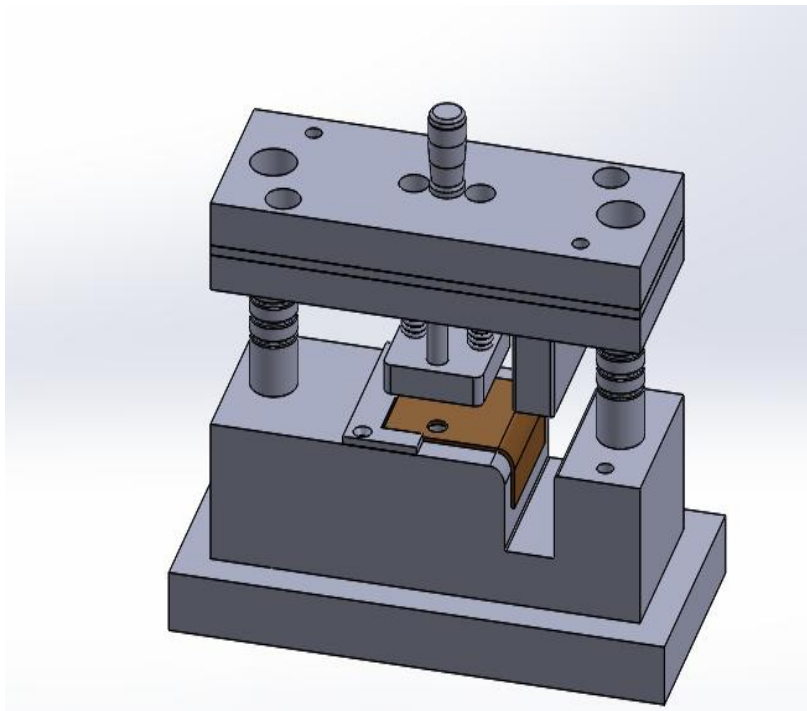
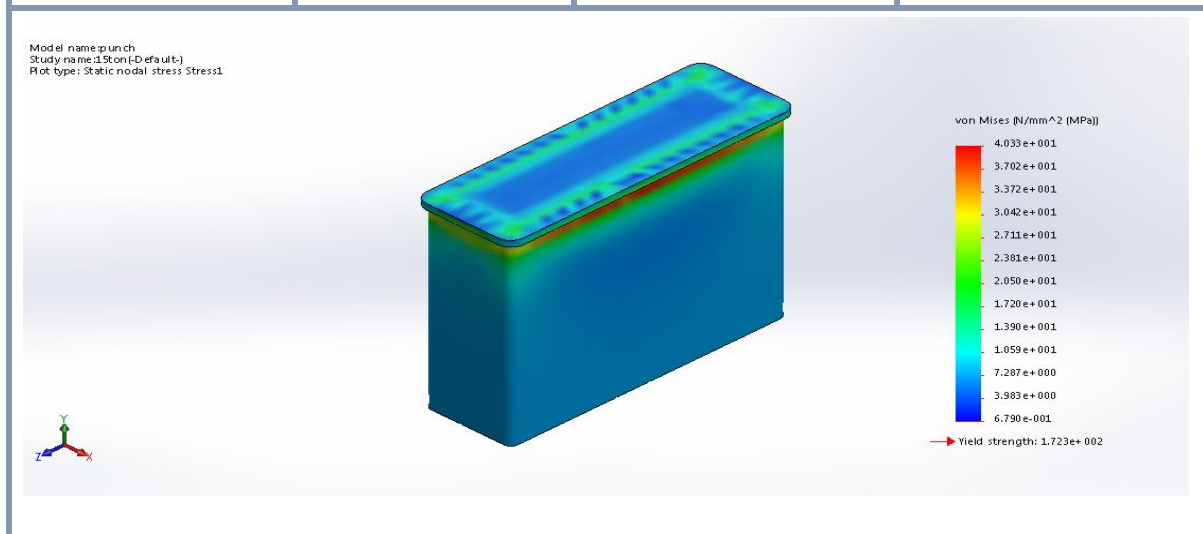


Fig 12: Punching and bending of sheet metal

Analysis of Punch and Die: The static analysis of punch is done by using stainless steel material by applying a load of 15ton and 20ton load. Study Results:

Name	Type	Min	Max
Stress1	VON: von Mises Stress	0.678995 N/mm ² (MPa) Node: 3326	40.3281 N/mm ² (MPa) Node: 9261



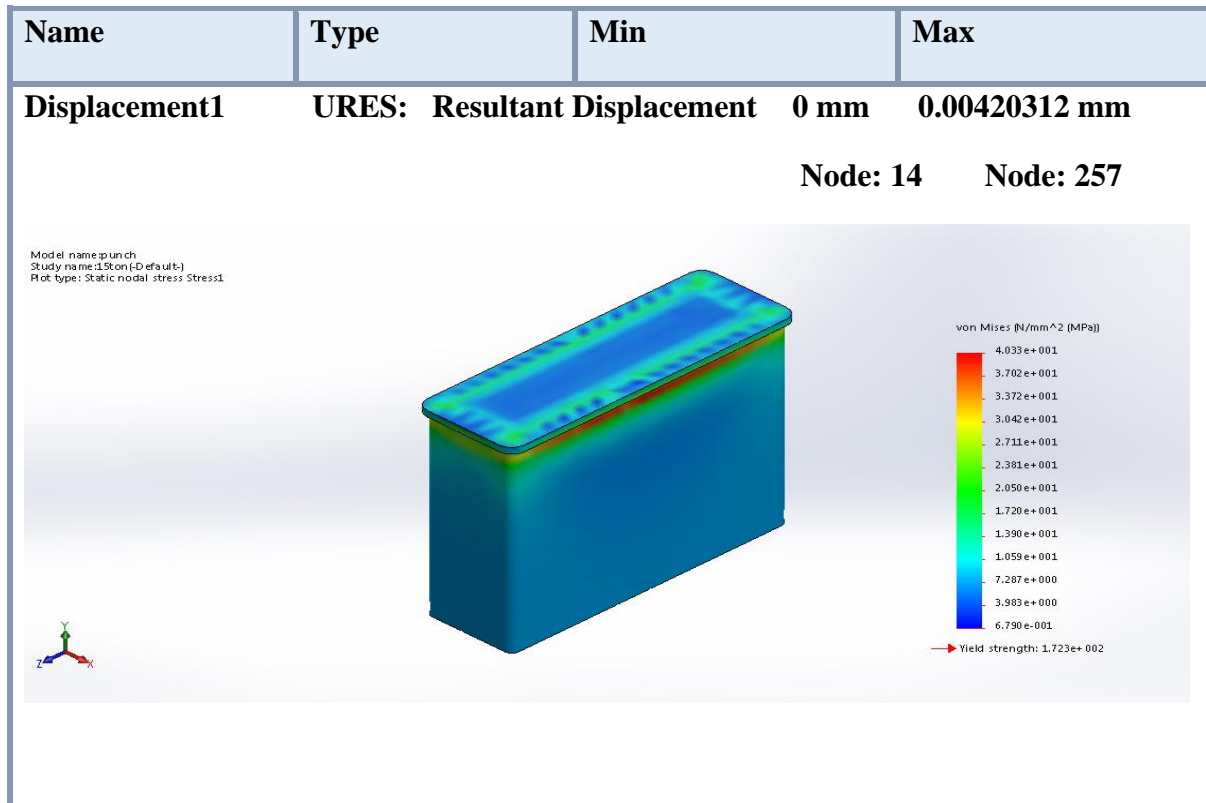
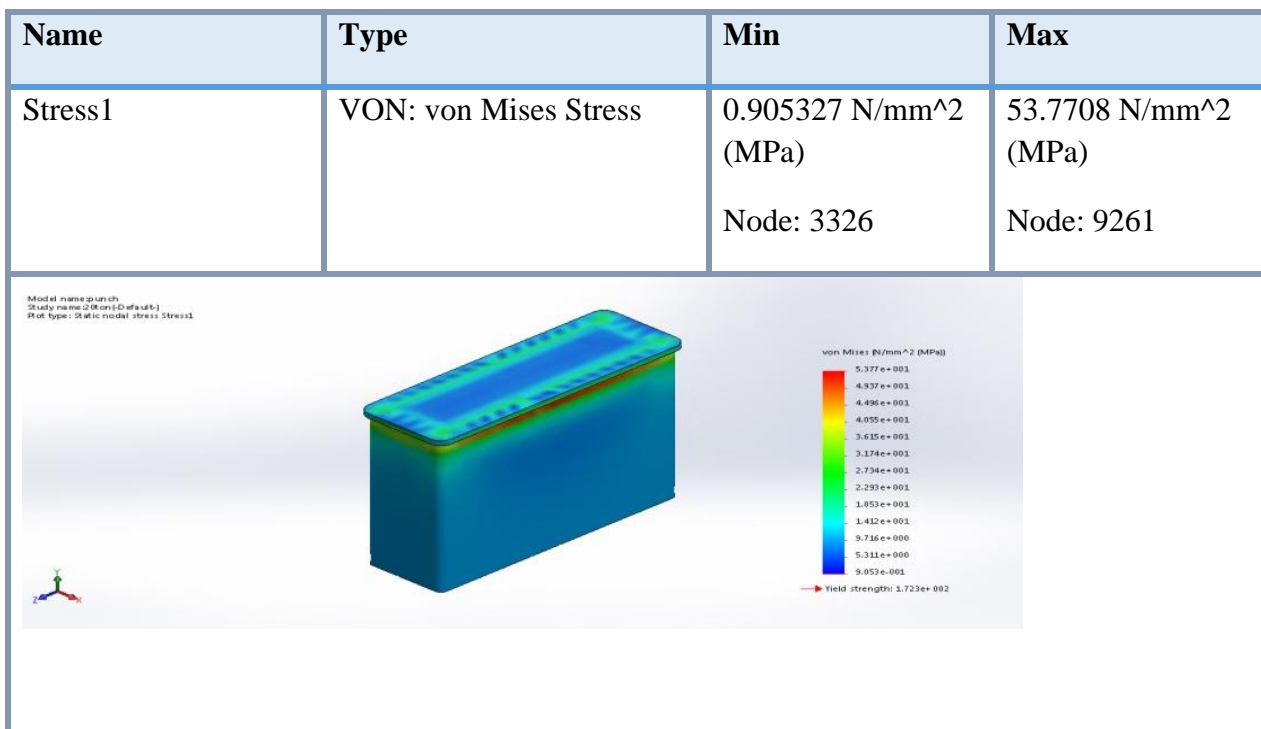


Fig 13: Analysis of Punch and Die

Static analysis of punch by applying 20tonn load using stain less steel material

By applying same boundary conditions and loading conditions the results are as follows:



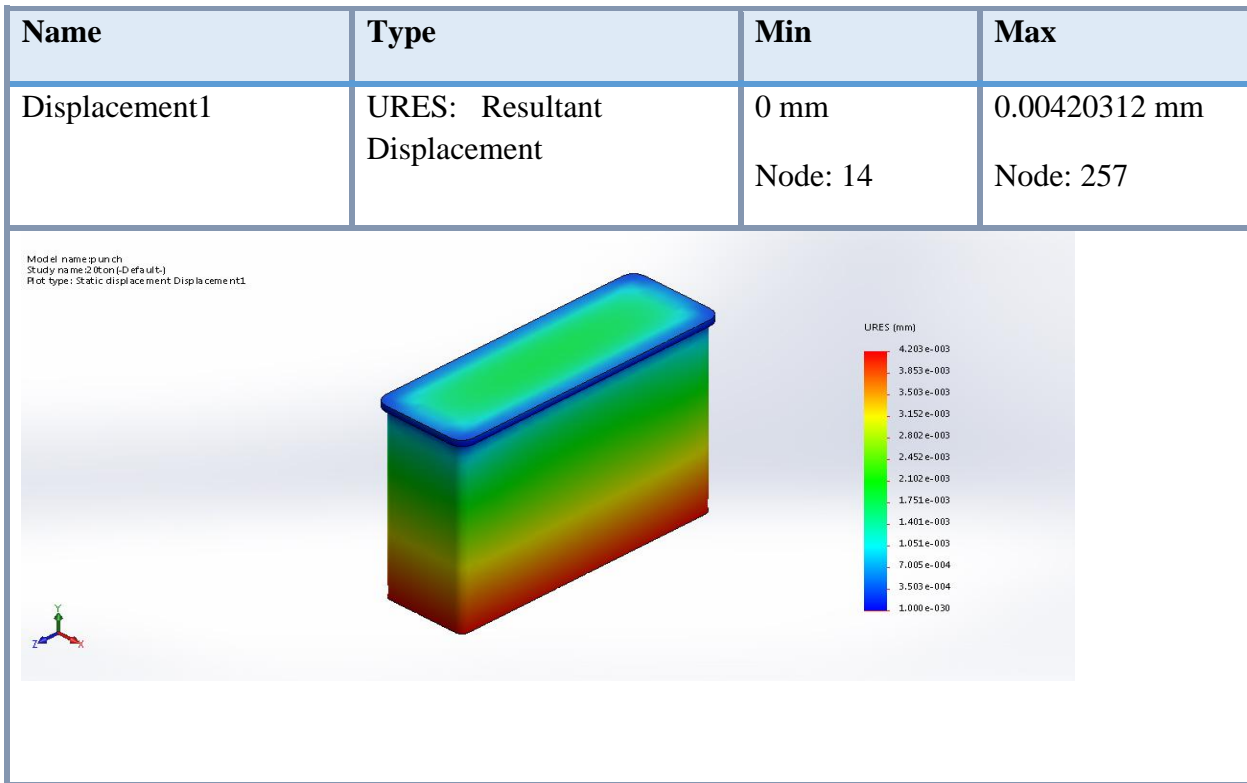
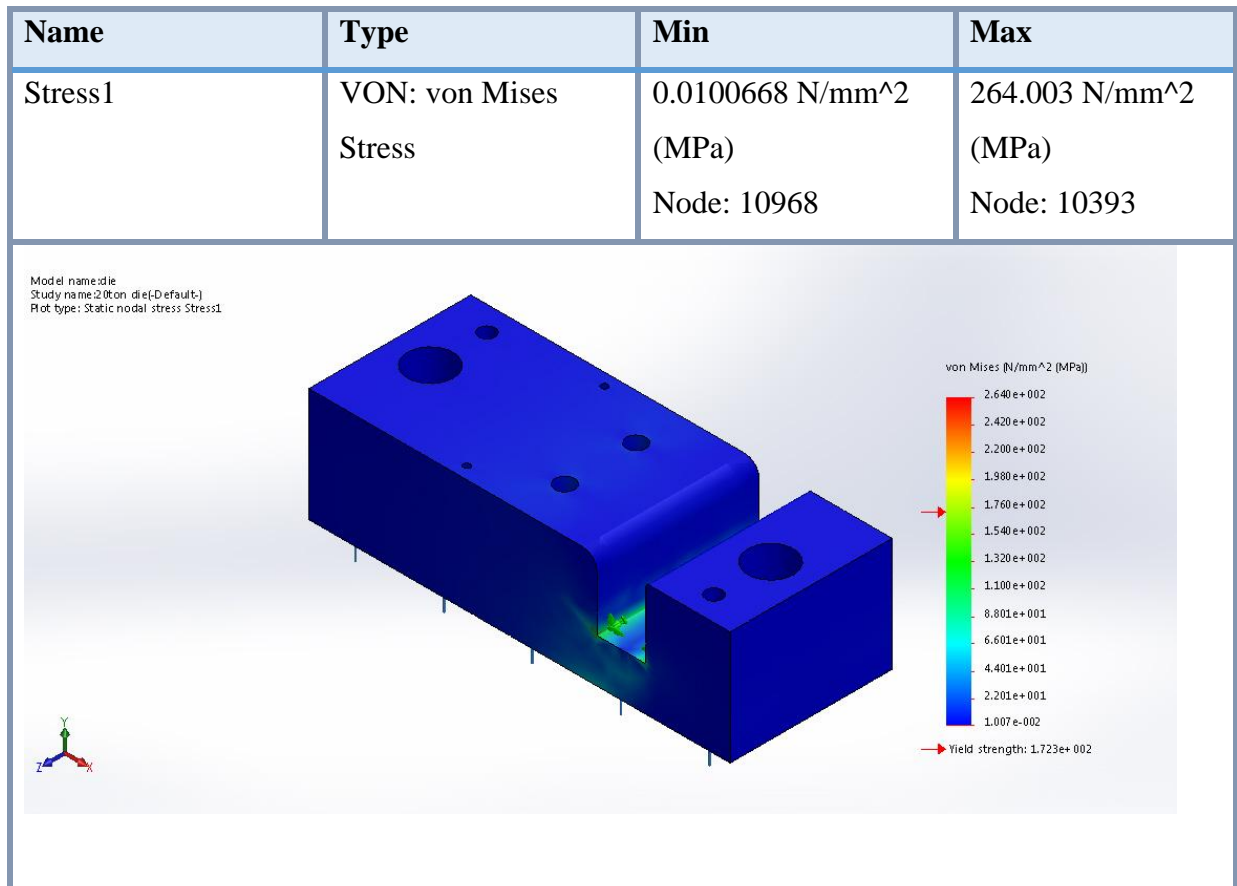


Fig 14: Static Analysis of Punch

Static Analysis of Die by Applying 20Tonn Load Using Stain less Steel Material



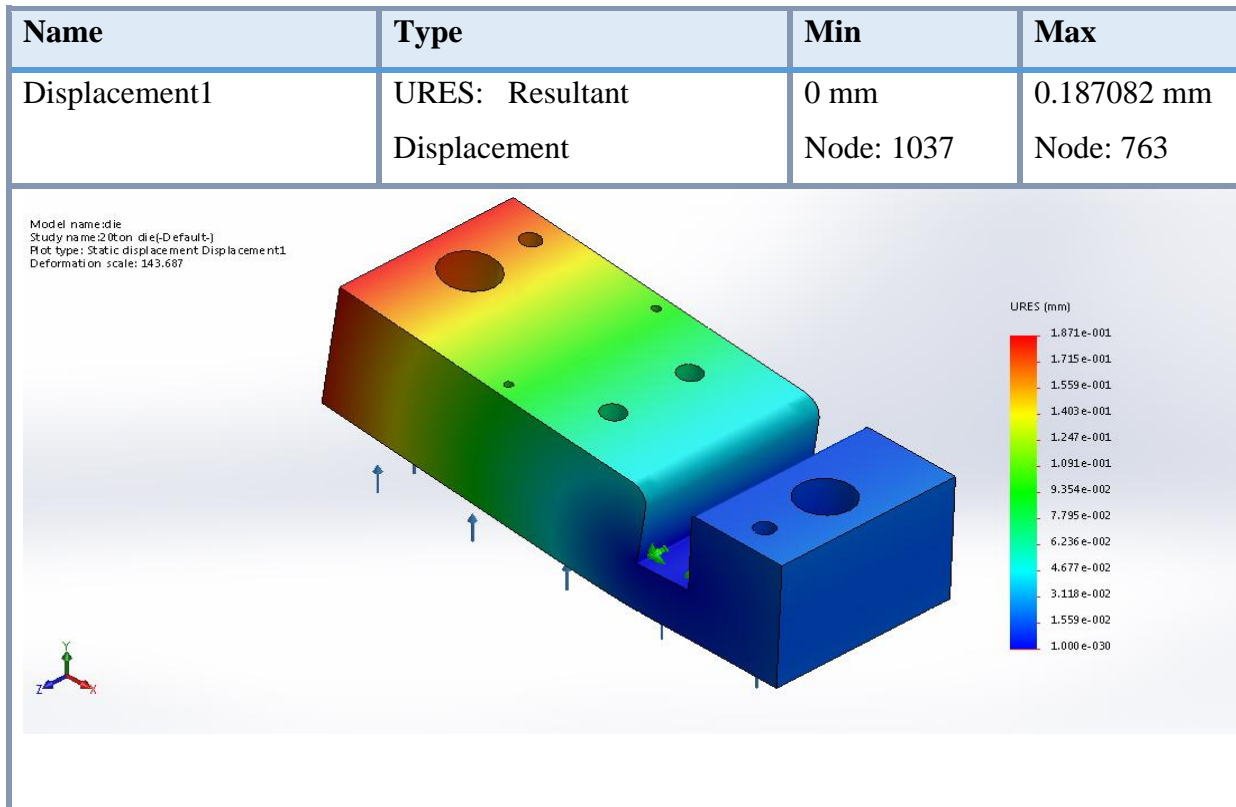


Fig 15: Static Analysis of Die

RESULTS AND DISCUSSIONS

The structural analysis of the punch and die is done by applying stainless steel material 15 ton and 20ton loading conditions.

Comparison of results for punch and die load of 15 tonn:

S.No	Punch	die
Stresses developed [Mpa]	40.3	148.1
Resultant displacement [mm]	0.003	0.14

Comparison of results for punch and die load of 20 tonn:

S.No	Punch	die
Stresses developed [Mpa]	53.77	264.2
Resultant displacement [mm]	0.004	0.18

By observing the above results for 15 ton load the punch and die are within the safe limits i.e., less than the material yield strength. But for the 20tonn load the punch is within the safe limit where as die has yielded more stresses than material yield strength. So 15ton load is safe operated for punch and die.

CONCLUSION

In this project work some significant aspects of press tool design for chain guide mounting bottom brocket is discussed and also detail study and analysis were carried out. Both in punch and die maximum stress developed was very less when compared to the calculated value. Through static analysis it confirms that the material selected for both punch and die are safe. Punch and die designed is made detachable so that only the damaged part is replaced. By incorporating finite element method overall production rate is optimized. The results reveal that by integrating CAD/CAE will be highly beneficial. By the implementation of computer in design, accuracy of design is improved and design process time is reduced drastically than by traditional method. Many design problems which are complicated to eliminate by traditional methods are eliminated by using CAD system.

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