

OPTIMIZATION OF UPPER PUNCH, LOWER PUNCH, PLATE OF TABLET PRESS MACHINE

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Abstract: - The preferred drug delivery system today is represented by tablets, which are manufactured using tablet press machine in which powder is filled in a die and that powder is compressed in a die by upper and lower punch. The objective of the project is to relook into the design of the machine and to reduce the weight of machine component like Upper Plate, lower roll housing, upper roll carrier. 3D CAD model of rotary tablet press is prepared in Solid Edge. Deflection and stresses at various critical points are determined using FEA tools. Redesign and optimization of the same components of machine is carried out Considering the Tablet Specification Manual standards at the same time keeping comparable machine structure accuracy and productivity.

I. INTRODUCTION

Tablet press machine mainly consists of Upper roll assembly, Turret assembly, Upper Plate, Middle plate, Base Plate, Side Pillar, Main compressor and Pre compressor assembly and drive assembly.

Upper roll assembly consists of two upper press roll and upper press roll shaft and it is bolted with Upper Plate. Powder is compressed in a die which is set at die face in turret and both upper and lower punches are inserted in turret. Turret, roller and thrust bearings, die and punches makes whole turret assembly. Upper Plate is mounted on a side pillar.

On the Middle plate other sub-assemblies like force feeder assembly, worm shaft assembly, electrical controls are mounted. Base plate also holds the partial weight of the head assembly. Main Motor is mounted on a Base plate. Main Compressor assembly and Pre Compressor assembly apply 12 Ton and 6 Ton force on a Lower Punch. Drive assembly consists of Center shaft.

Fig. 1 shows the CAD model of UNIC II SE Machine. When machine is working condition it creates very high reactive forces, so to withstand them machine structure should be designed properly based on rigidity.

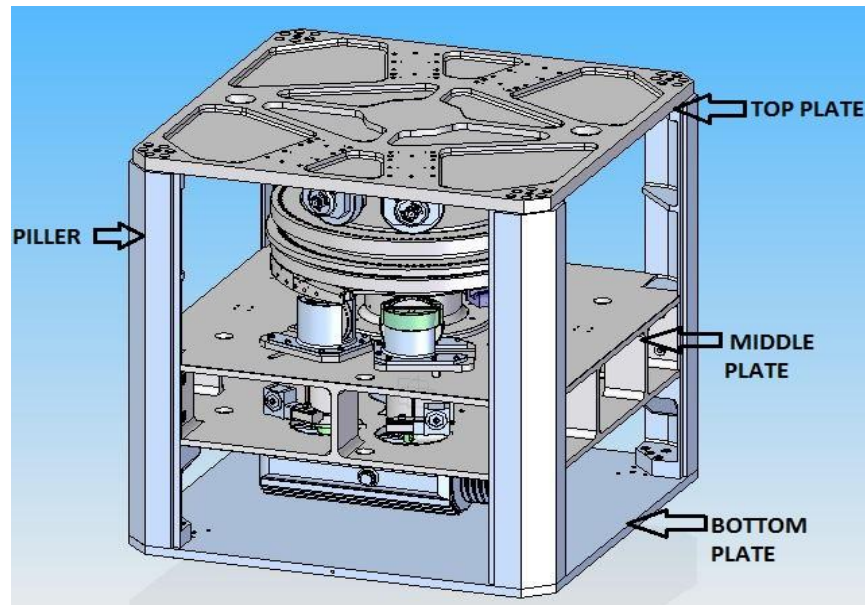


Fig 1 CAD model of UNIC II SE machine

Manolis Papadrakakis [1] has given advanced solution methods in topology optimization and shape sensitivity analysis. **Ajit S. Narang** [2] has done effect of force feeder on tablet strength during compression. **Marco Cavazzuti and Luca Splendid** [3] show structural optimization of automotive chassis: theory, set up, design. **G. Chiandussi** [4] has done Topology optimization with optimality criteria and transmissible loads.

FEA of Machine Components

The static force analysis of some components of UNIC II SE machine has been carried out by considering the severe loading condition. The various machine components are modeled using CAE software. The meshing of the various components is done using Hyper Mesh. The displacement and force boundary conditions are applied and stress and displacement fields obtained using finite element analysis software. Fig 2 shows the constraints and loads of Lower Roll Housing of Pre Compressor Assembly. The von-Mises stress and deformation contour plots for Lower Roll Housing are shown in Fig. 3 and Fig. 4 respectively.

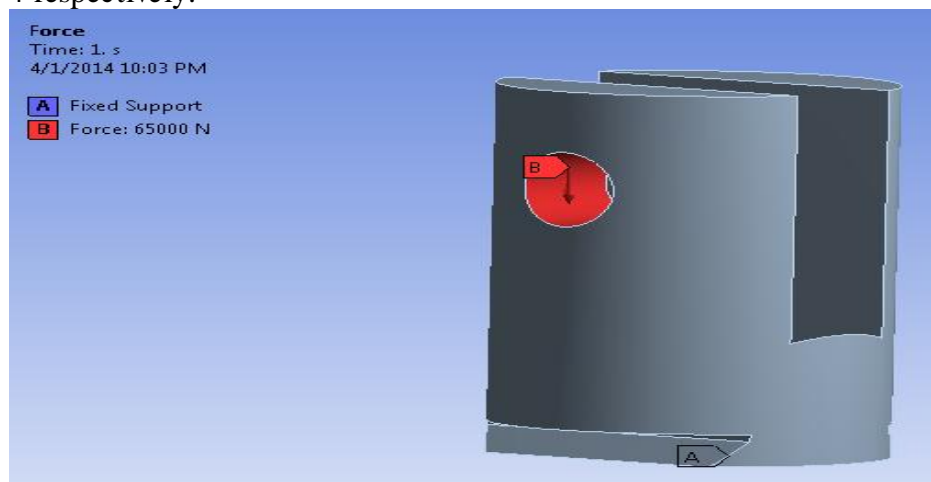


Fig 2 constrains and loads of Pre Compressor Lower roll housing

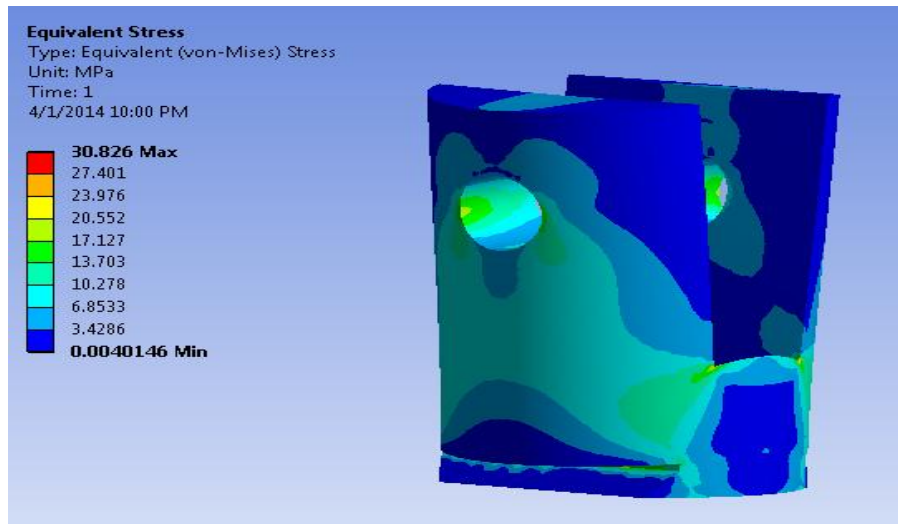


Fig 3 Equivalent Stress of Pre Compressor Lower roll housing

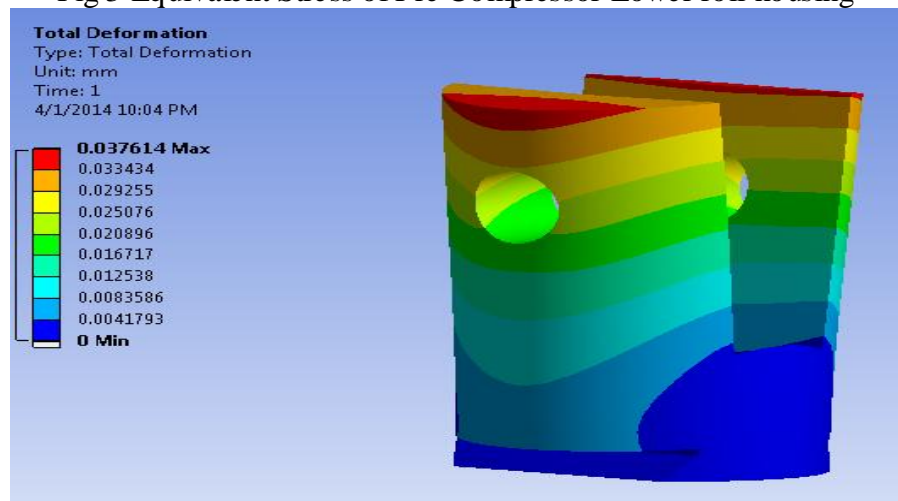


Fig 4 Deformation contour of Pre Compressor Lower roll housing

Main compressor lower roll housing has the same dimension of pre compressor lower roll housing but the difference is 10 Ton force acting instead of 6.5 Ton. Table 1 shows the results of pre compressor and main compressor lower roll housing.

Table 1 Result of Pre Compressor and Main Compressor

Sr No	6.5 Ton	10 Ton
Equivalent Stress	30.82 MPa	47.424 MPa
Total Deflection	0.03761 mm	0.05786 mm

Fig 5 shows the constraints and loads of upper plate. The von-Misses stress, maximum principle stress and deformation plots for upper plate are shown in Fig. 6, Fig. 7 and Fig 8 respectively.

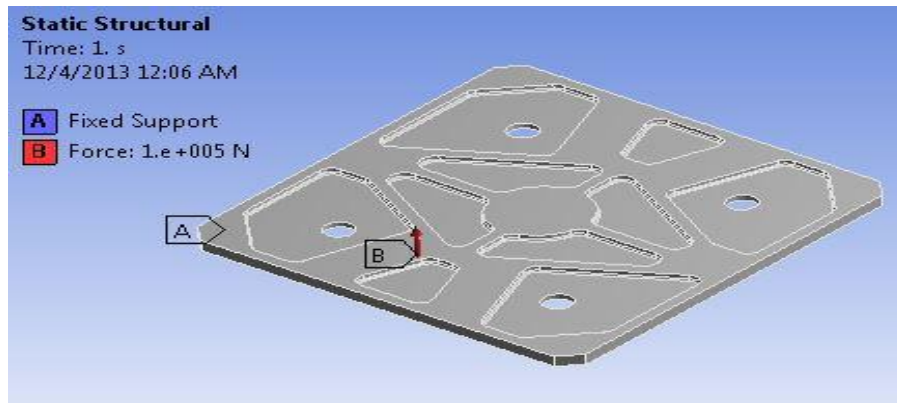


Fig 5 Constrain and Loads of Upper Plate

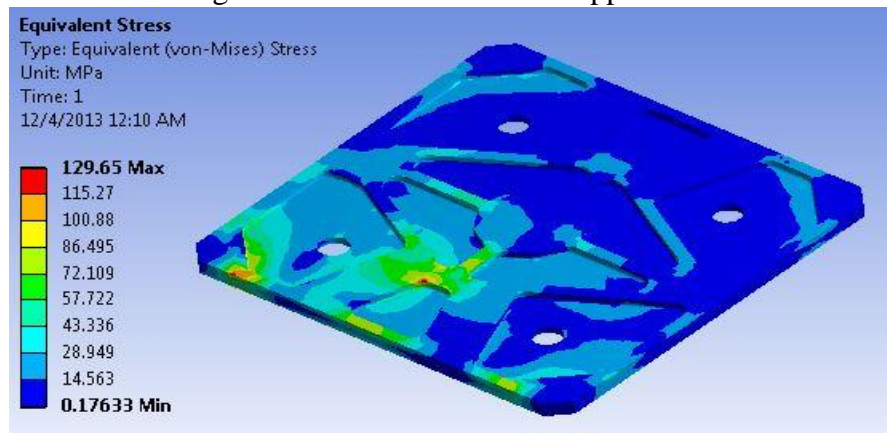


Fig 6 Equivalent Stress of Upper Plate

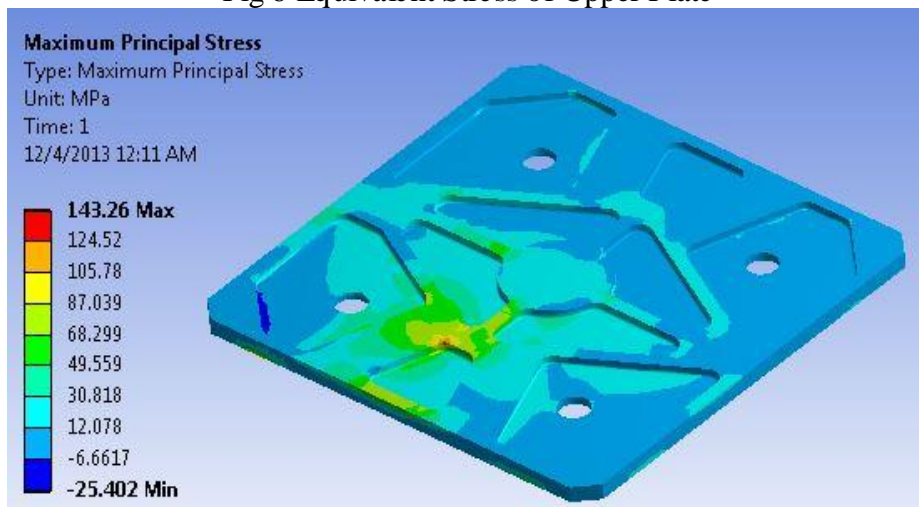


Fig 7 Maximum Principal Stress contour of Upper Plate

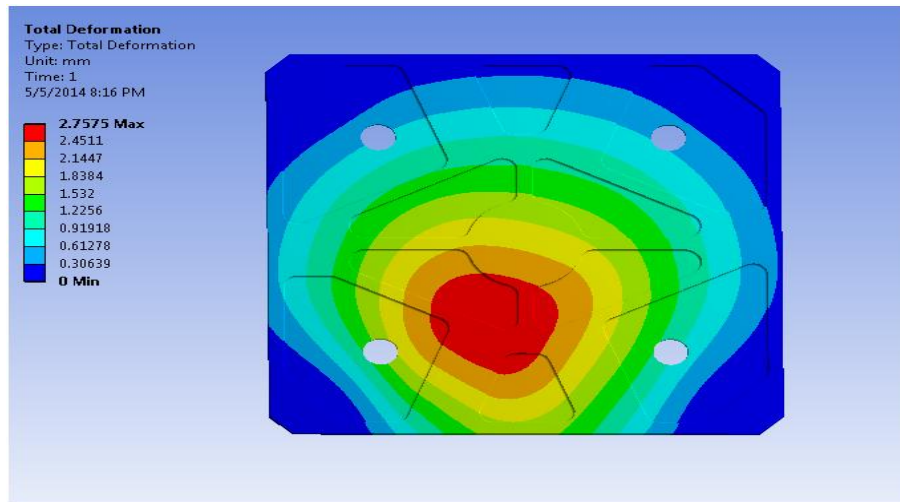


Fig 8 Deformation contour of Upper Plate

Optimization and Modification

After static analysis of Pre Compressor and Main Compressor Lower roll housing, shape optimization is carried out using Ansys. After applying Load and constrain, Fig 9 shows the shape optimization and optimized geometry of pre compressor and main compressor lower roll housing.

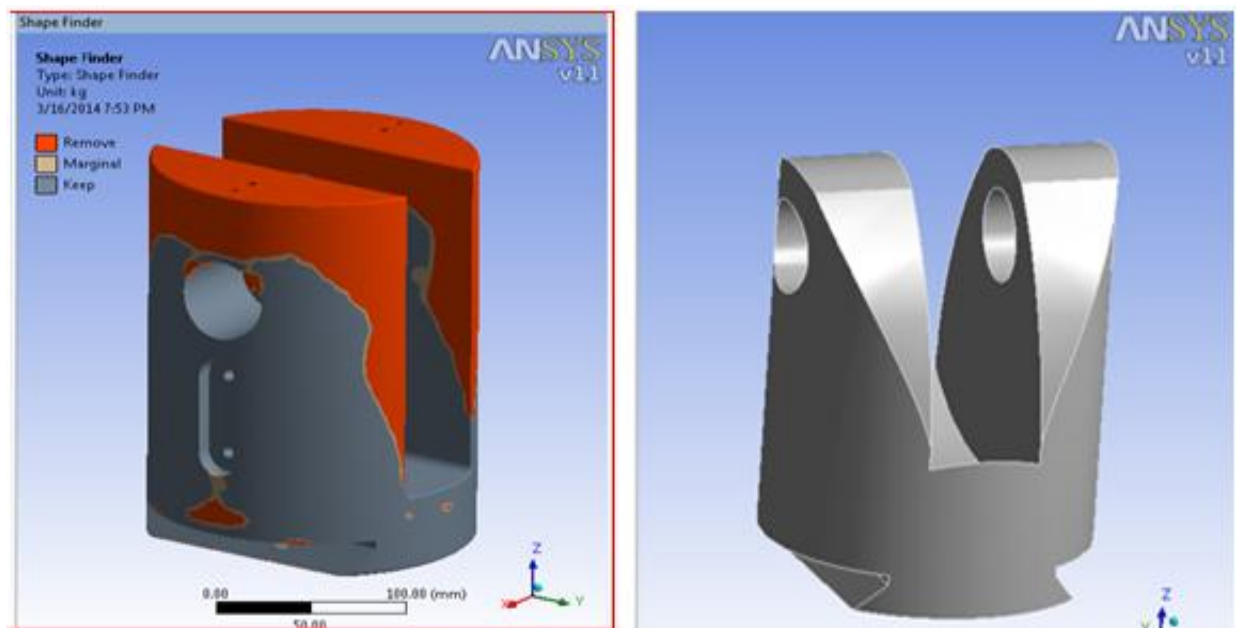


Fig 9 Shape optimization and optimized geometry

Static analysis is again carried out of optimized geometry using same loading condition. Table 2 shows the comparison table of existing lower roll housing and modified lower roll housing in terms of stresses and weight.

Table 2 Comparison table of Lower roll housing

Sr No	6.5 Ton	10 Ton
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	Existing Component	Modified Component	Existing Component	Modified Component
Max Principal Stress	24.20 Mpa	27.35 Mpa	66.8 Mpa	42 MPa
Equivalent Stress	30.8 Mpa	28.22 Mpa	47.42 Mpa	43.4 Mpa
Total Deflection	0.037 mm	0.035 mm	0.057 mm	0.054 mm
Weight	28.6 kg	24.09 kg	28.6 kg	24.09 kg

Topology optimization of upper plate is carried out in the HYPERMESH.09. For the optimization purpose design and non design areas are defined. Red zone defined as a design area, from where material can be remove during optimization, whereas the green zone defined as a non design area where in any situation material can not be removed.

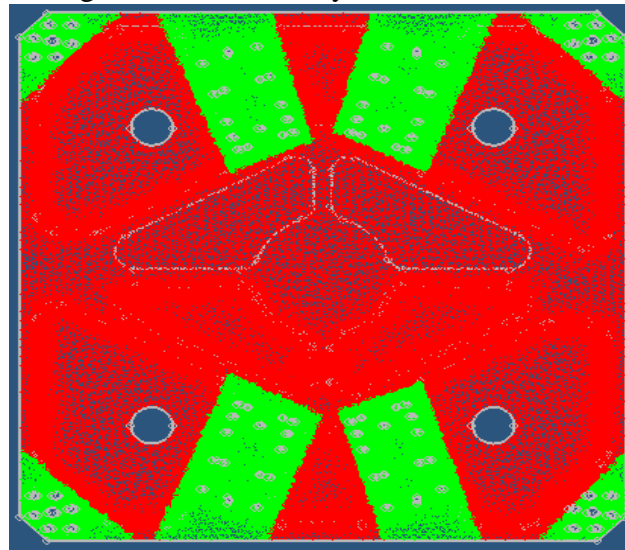


Fig 10 Design and Non Design portion of Upper Plate

After applying boundary condition and forces to the component do the optimization in the HYPERMESH. To solve this problem 15 iteration took place and at different iteration the density distribution is shown in Fig 11. In Fig 11 it can be seen at final iteration (Iteration 15) of optimization, some of the design area is fall in blue zone which shows the state of void but it's not possible to remove all the material from the blue zone of the component, some density threshold is defined to keep the material in optimized result.

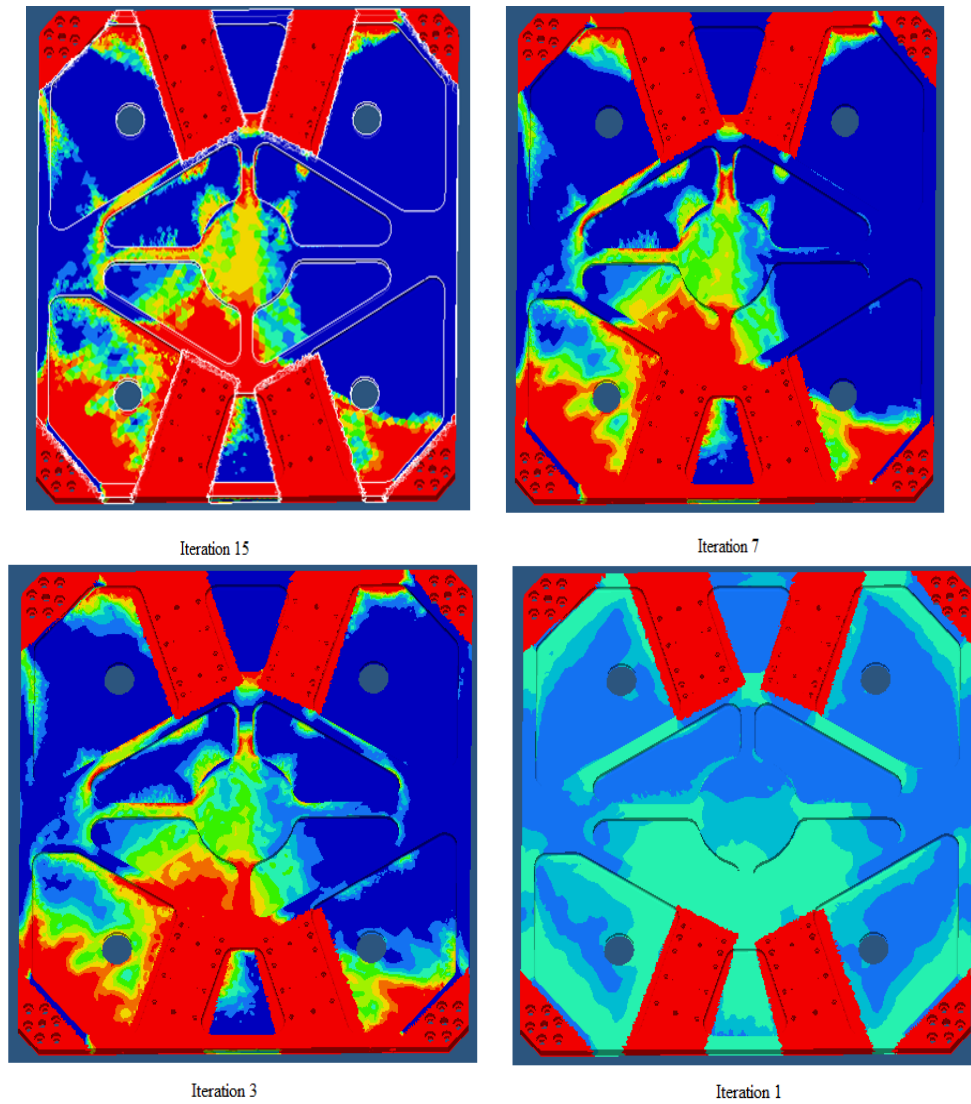


Fig 11 Topology Optimization of Upper Plate

After complete topology optimization, remove the material approximately and do analysis again with same loading condition and constrain in ANSYS. Fig 12 shows the model after removing excessive material. Table 3 shows the comparison table of existing upper plate and modified upper plate in terms of stresses and weight.

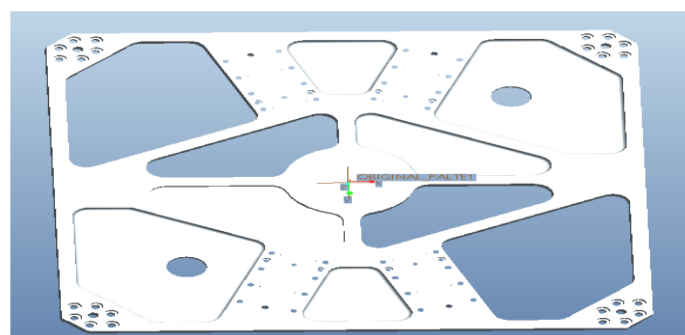


Fig 12 Optimized Upper Plate

Table 3 Comparison of Plate

Sr No	Existing Component	Modified Component
Max Principal Stress	143.2 Mpa	209.4 Mpa
Equivalent Stress	129.6 Mpa	188 Mpa
Total Deflection	2.75 mm	2.33 mm
Weight	945 kg	822 kg

CONCLUSION

Optimization of Pre compressor lower roll and Main compressor lower roll are completed, Pre compressor upper roll carrier, Main compressor upper roll carrier and Upper plate is done by using ANSYS and HYPERMESH. After optimization of components, overall 158 Kg weight is reduced having the cost of around 11000 Rs.

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