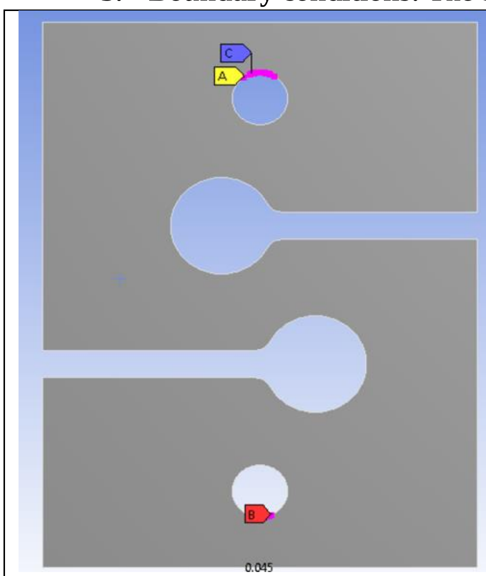
Design report Surya Shekhar

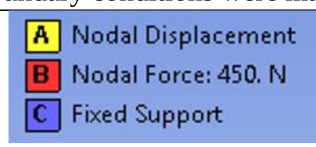
1. **Material Selection for analysis:** As per the problem statement, the plate needs to absorb maximum strain energy. Now as we know, higher the young's modulus more brittle the material will be and lower the poissions ratio lesser will be lateral deformation. Therefore ideally the worst material condition will be young's modulous = 3000 Mpa and Poissions's ratio = 3.5. If the actual material has a E<3000 and v>3.5, will be an added advantage.

2. **Design criteria:** This design is made to prevent the cord from braking and provide a drop height for which the plate will not fail, When the height increases the plate must break, this concept can be used as stress buffer to protect an appliance from excessive stress.

   Design and analysis process: If the slots on the plate is cut in such a way that when the axial force acts on the plate, certain region of the material experiances bending. And the analysis was done in Ansys <u>using plane stress to check for the maximum principal stress and and stiffness</u>. Four iterations were made to reach the most convincing design, where the Maximum principal should be less than 80Mpa which is the yield stress of plexiglass and the stiffness value was supposed to be minimum. <u>Mesh was created with quadratic element with element size 3mm.</u>

3. **Boundary conditions:** The boundary conditions were made realistic to suit the actual loading conditions.



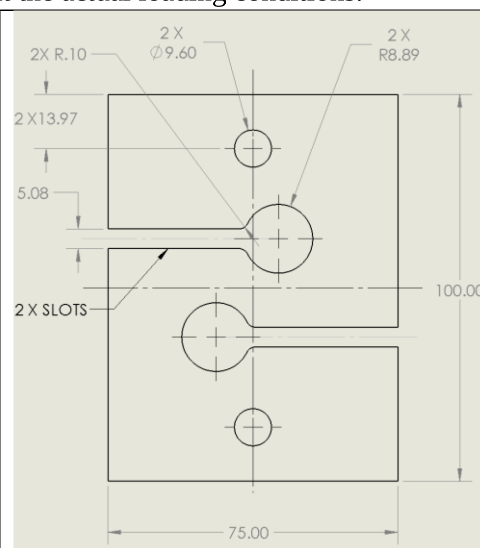


Fixed support is applied on 5 nodes of the upper circumferance of the top hole. (motion along x=0 and y=0).

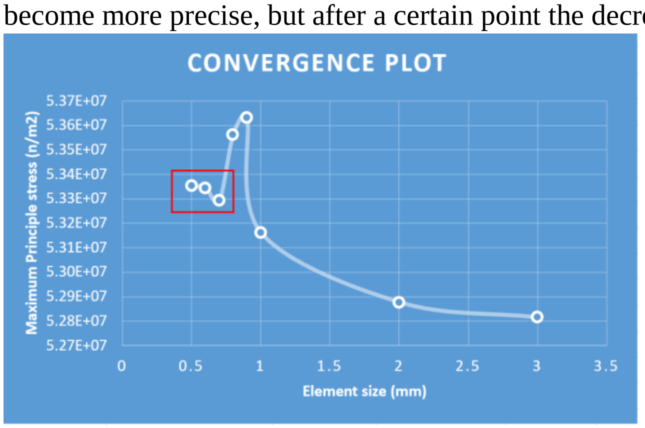
Roller support is applied on the nodes, either side of the nodes of fixed support.
(Motion along y is free and x=0)

Force is applied on 5 nodes of the bottom circumferance of the bottom hole (F= -450N along Y direction)

Net effect: Translation along X=Z=0, Rotation about Y & X completely restricted and rotation about Z is restricted, but deformation is allowed.

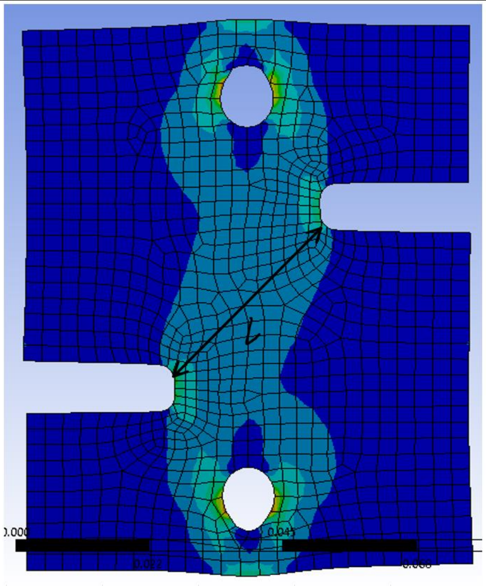
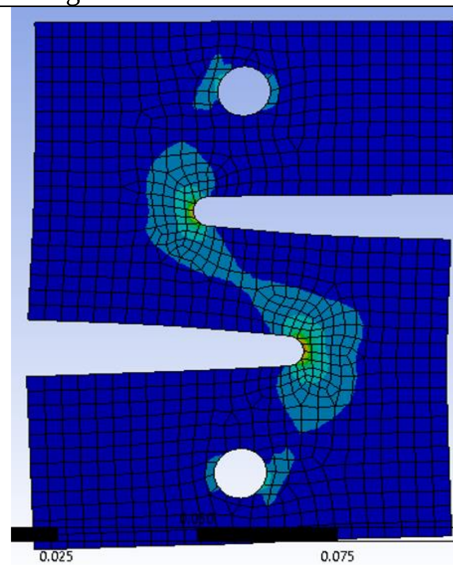


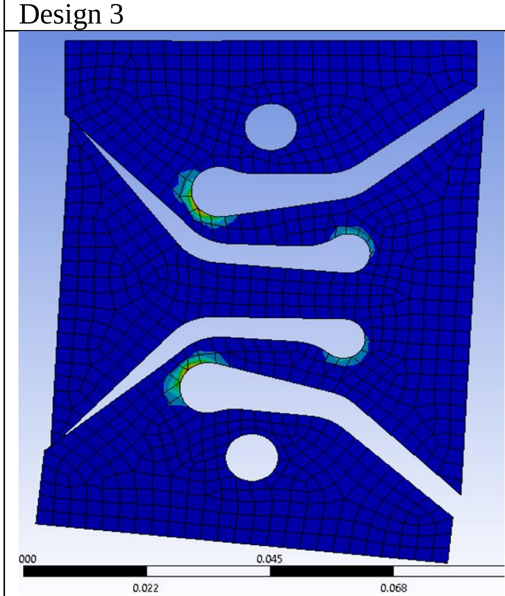
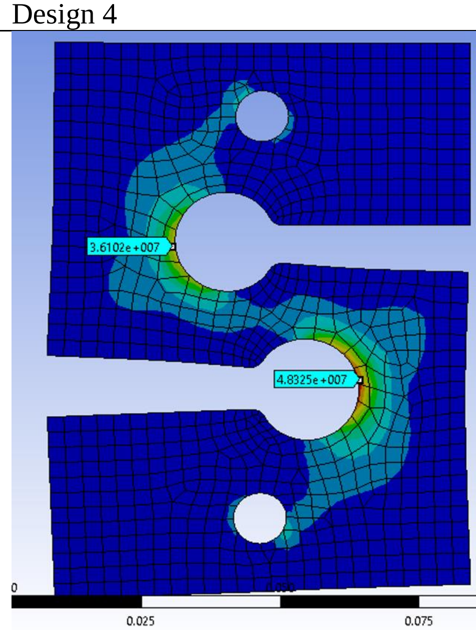
4. Mesh Convergence study: With the dectrease in element size the number of elements increase and the results become more precise, but after a certain point the decrease in element size deoesnot effect the results.



Element Size (mm)	Max Principal Stress (N/m^2)
3	5.28E+07
2	5.29E+07
1	5.32E+07
0.9	5.36E+07
0.8	5.36E+07
0.7	5.33E+07
0.6	5.33E+07
0.5	5.34E+07

5. **Design of Geometry modification:** Finite element analysis was made on every design and based on the results an observation was made and some changes were made on the parameters for next design.

Design 1		Design 2	
	Max Principal Stress: 15.3 N/mm^2 Stiffness: 3.12E+03 N/mm Max Deformation: .144 mm Observation: Though Max Principal stress is in limit, stiffness is very high and need to be reduced, this was done by reducing the length 'L'. And max stress is concentrated near the hole ehich needs to be spread.		Max Principal Stress: 49.67N/mm^2 Stiffness: 15.14E+02 N/mm Max Deformation: .876 mm Observation: Siffness falls drastically due to bending, and max principal stress increases but remains below 80Mpa. However another iteration with 4 slot design can be made to achive a much better stiffness value

Design 3		Design 4	
	Max Principal Stress: 499 N/mm^2 Stiffness: 51 N/mm Max Deformation: 8.79 mm Observation: A design was tried narrow slots to increase the bending effect. This design gave exceptionally high deflection and a stiffness 100 times lower. But the Maximum principal stress was too high. This was rejected and the 2 slot design was futher optmized		Max Principal Stress: 52.8 N/mm^2 Stiffness: 173.745 N/mm Max Deformation: 2.59 mm Observation: The max principal stress obtained in low giving a FOS=1.51. The stiffness value falls down by 10 times with the addition of big holes at the end of the slots, giving a decent stiffness.

Conclusion: Design 4 is selcted because of low stiffness and an decent factor of safety of 1.51.