Introduction: Name - Ujjawal Jha

A device with a gage section was designed to transform a compressive load from a vice into uniform tensile stress within the gage section. The analysis was performed in ANSYS using 2-D models with a **plane stress condition** since the thickness is very small compared to length and breadth.

Description of data:

1. Material properties

The test subject is made from PMMA (Plexiglass), The Poisson ratio ranges from 0.35-to 0.4, but **0.35** was specified for all analyses. The tensile strength of PMMA ranges from 48-76 MPa, but **48 Mpa** was chosen to design the safest design, and Young's modulus ranges from 1800-3100 MPa, **1800 Mpa** was chosen. The plots of the maximum principal stress and strain are shown below.

2. Mesh data:

The meshes were generated with mostly quadrilateral elements. A mesh refinement was applied to the edges of the slot using an edge sizing tool (stress-concentration) to make the element size 5-10x smaller than the radius of the slot. Quad8 (second-order) elements were chosen to generate accurate solutions.

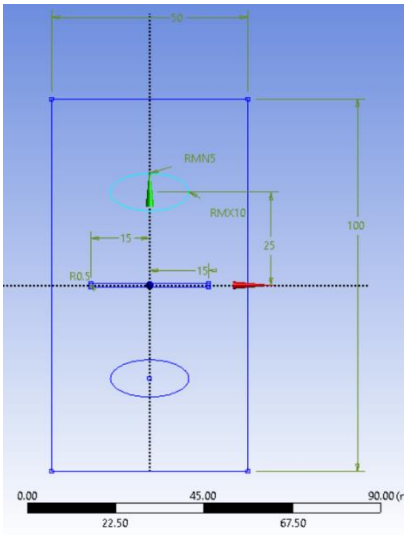
3. Type of analysis:

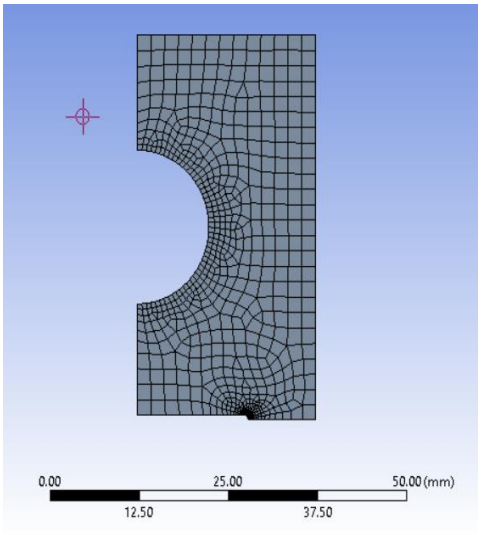
2-D models with a **plane stress condition.**

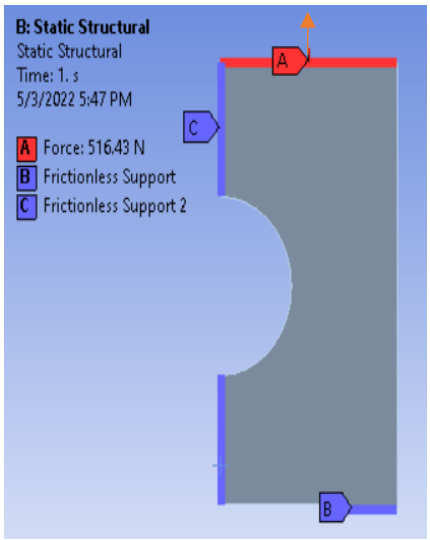
Maximum plane stress and maximum plane elastic strain were calculated because of the brittle nature of the material.

4. Boundary conditions:

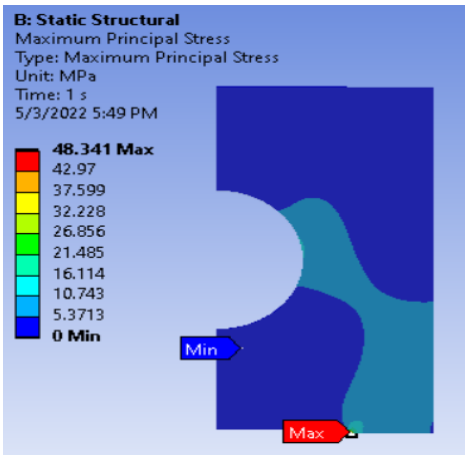
A distributed load in the y-direction, $F(=1032.86N)$, was applied to the top and bottom of the device. Moreover, the ANSYS Symmetry Tool was used to model ¼ of the device since **the device is symmetric with respect to the ZX and YZ planes**. The only modification necessary to simulate the ¼ symmetric model is applying **F/2(=516.43N) the distributed load on the top edge.** Since the ANSYS tool was used, no boundary conditions at the bottom of the symmetric model are needed. Analysis was performed on the ¼ symmetric model.

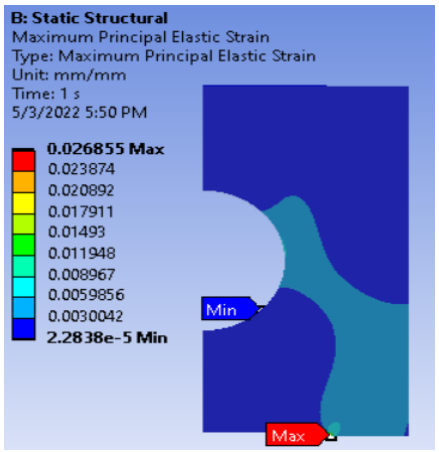




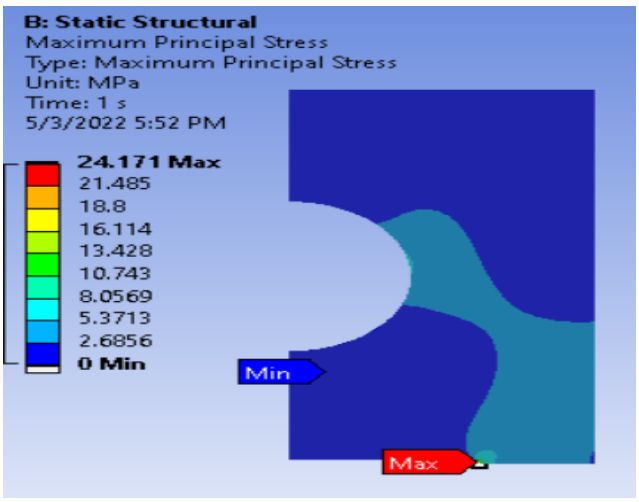


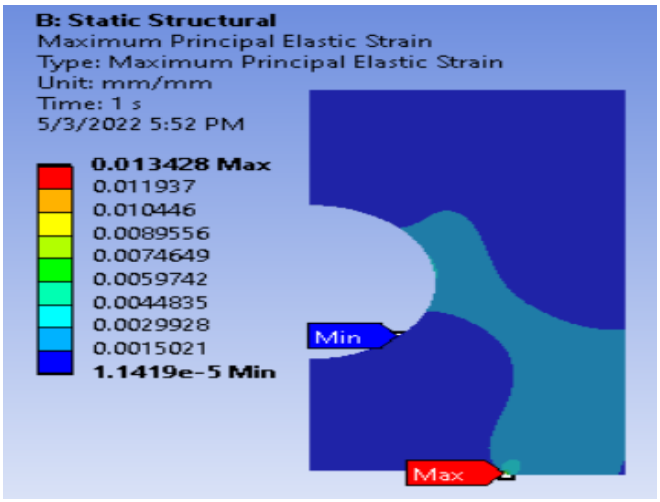
Mesh Metric	Element Quality
Min	0.65764
Max	0.99989
Average	0.95047
Standard Deviation	4.7564e-002
Inflation	
Batch Connections	
Advanced	
Statistics	
Nodes	2220
Elements	693



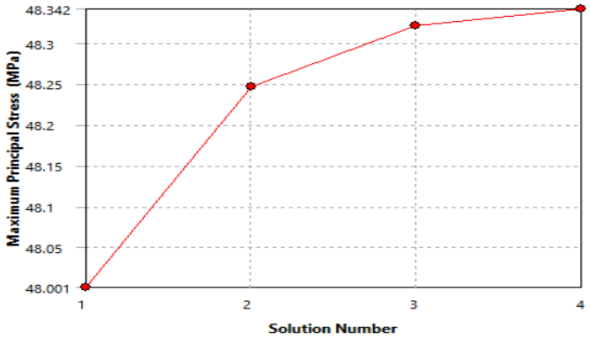


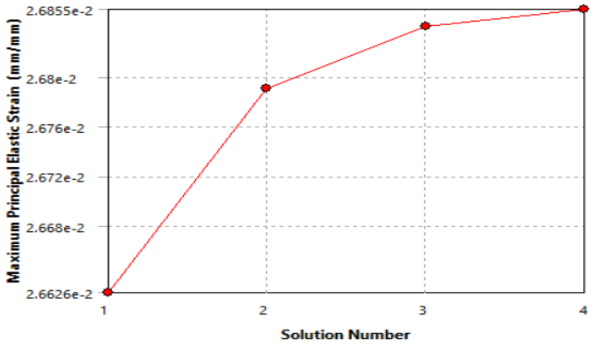
50% load (post convergence)





Convergence Analysis: 0.1% convergence criteria chosen





	Maximum Principal Stress (MPa)	Change (%)	Nodes	Elements
1	48.001		2220	693
2	48.247	0.51029	3542	1129
3	48.322	0.15524	5300	1703
4	48.342	4.1594e-002	11518	3753

	Maximum Principal Elastic Strain (mm/mm)	Change (%)	Nodes	Elements
1	2.6626e-002		2220	693
2	2.6791e-002	0.61642	3542	1129
3	2.6841e-002	0.18804	5300	1703
4	2.6855e-002	5.2226e-002	11518	3753

Parametric study (design optimisation):

For parametric study max force calculated by increasing the force **from 400 Mpa to 550 Mpa** by keeping an upper bound in **maximum principal stress being less than 48Mpa.**Also the width and Y-coordinate of the ellipse were parameterized to change and optimize to maximize the load that can be applied.

Table of Schematic C2: Optimization

	A	B	C	D	E
1	Name	P6 - Force Y Component (N)	P11 - Height (mm)	P12 - Fat (mm)	P5 - Maximum Principal Stress Maximum (MPa)
2	1	491.67	25	10	45.699
3	2	575	25	1	57.071
4	3	408.33	15	10	38.704
5	4	441.67	25	1	43.837
6	5	458.33	25	10	42.601
7	6	425	15	1	41.973
8	7	525	15	10	49.762
9	8	591.67	15	10	56.081
10	9	475	15	1	46.911
11	10	541.67	25	10	50.347
12	11	508.33	25	1	50.454
13	12	558.33	15	1	55.141
14	13	441.21	15	1	43.574
15	14	562.38	15	1	55.541
16	15	508.91	15	10	48.237
17	16	460.36	15	1	45.465
18	17	467.44	15	1	46.165
19	18	418.65	25	10	38.913
20	19	405.75	15	10	38.459
21	20	497.14	25	1	49.343
22	21	586.39	25	1	58.201
23	22	538.58	25	10	50.06
24	23 DP	516.43	25	10	48.001

Table of Schematic C2: Optimization , Candidate Points

	A	B	C	D	E	F	G	H
1	Reference	Name	P6 - Force Y Component (N)		P11 - Height (mm)	P12 - Fat (mm)	P5 - Maximum Principal Stress Maximum (MPa)	
2			Parameter Value	Variation from Reference			Parameter Value	Variation from Reference
3		Candidate Point 1 DP	516.43	0.00%	25	10	48.001	0.00%
4		Candidate Point 2	491.67	-4.79%	25	10	45.699	-4.79%
5		Candidate Point 3	475	-8.02%	15	1	46.911	-2.27%
*		New Custom Candidate Point	500		15	1		

NOTE: During the simulation it was observed that the ellipse transformed its shape to a circle of radius 10mm signifying that circles are an optimized shape to reduce stress.