Indian Institute Of Technology Roorkee

Engineering Analysis & Design Project Report on :

Analysis of Multi Functional Table

Team:M18

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ABSTRACT

Multipurpose foldable table is a new initiative business manufacturing top in the class table mates. This table can be used at various heights and at various angles hence being a 'multipurpose' table.

Thus, such an important component in an industry must be manufactured and designed in a way so as to deliver maximum performance without failure. Thus, the aim of the work is to study the stress application on the table and find the optimum design for the same.

Methodology: Our main aim was to reduce the stresses being applied on the table top and minimize the deformations. We achieve this by making two models, one that is commonly being used in the industry and the other where we make certain modifications to the design.

Key Results: Our results showed that the maximum deformation decreased, maximum stress and strain decreased in our modified model under different types of load varying conditions.

Key Conclusions: The factor of safety of the table can be increased by making some improvements. The improvements are table top's structure is changed and the truss structure was made hollow which was originally solid.

INTRODUCTION

The tables which we use in daily life have fixed heights and are sometimes uncomfortable.This gave rise to the need of having a table which can be used at multiple heights and use less space, that's why a multipurpose table came into existence. This table can be used as laptop table, study table, as well as dining table.This product is ergonomically good as well as cheap comparatively.

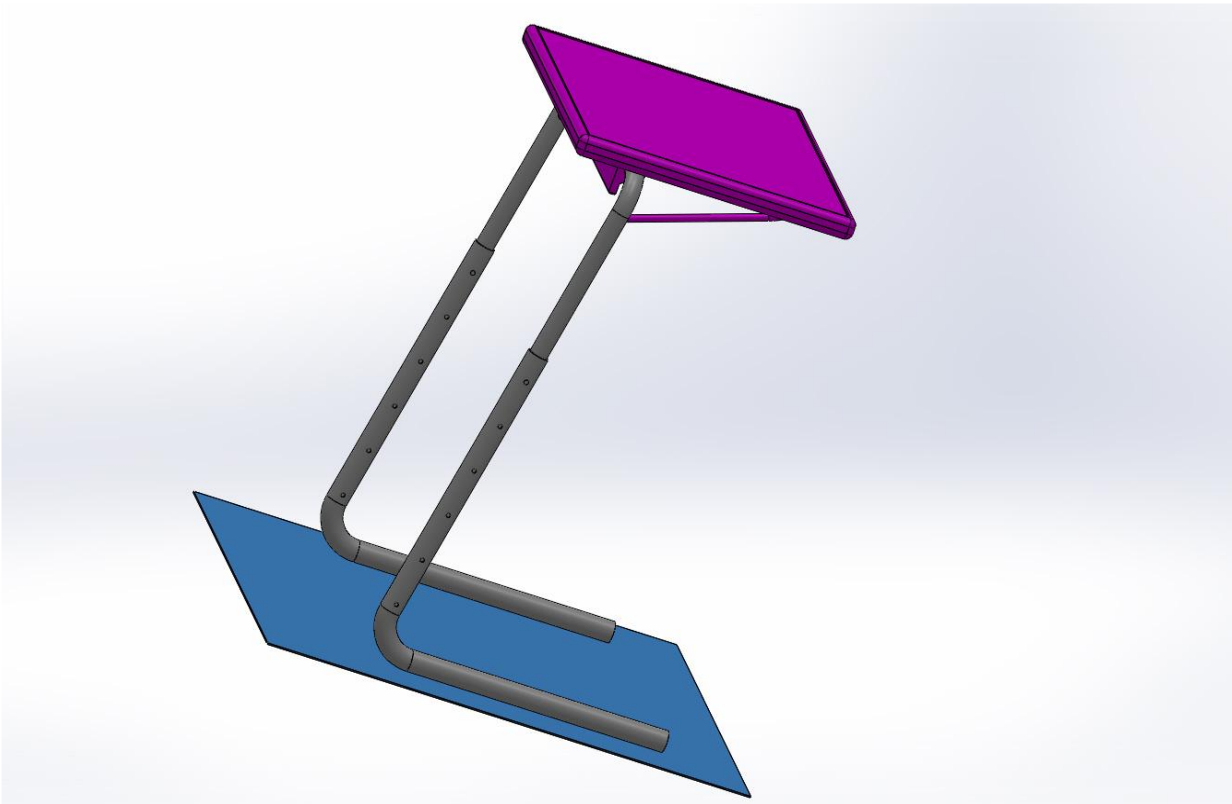
The aim of this project is to analyse how the stresses develop on this table and further find if there is any possibility of reducing it so as to minimize the deformations in the table.

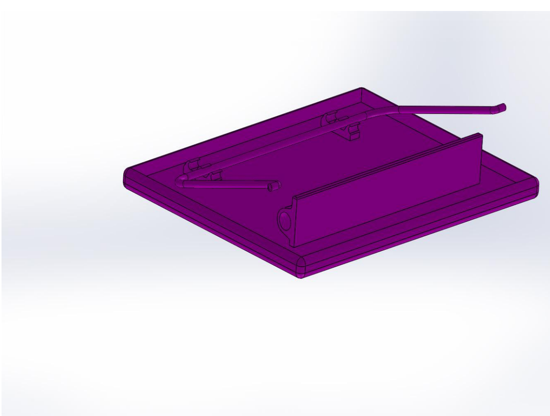
The project is carried out by making a model of the multipurpose table that is currently being used in the industry. On this model, stresses were analysed and also corresponding strains were figured out.

Then a new model is developed seeking to make changes in the design so as to figure out ways by which the deformations can be reduced and thereby reducing the possibility of its failure.

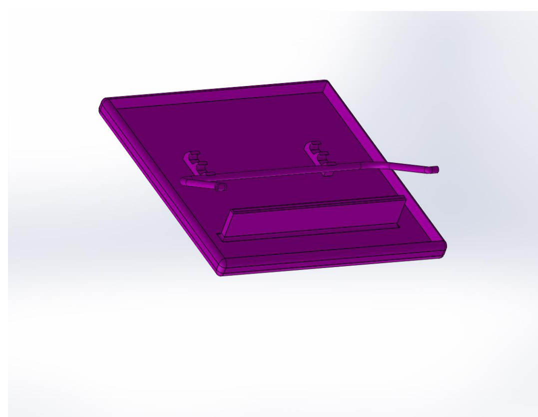
The project achieves reduction in the maximum equivalent stresses and strains with the help of these changes in the design.

CAD MODEL





Improved design of table top



original design of table top

DETAILS

The multi-functional table consists of 3 main parts:
1) Table Top
2) U shaped frame-The table top rests on it
3)Truss like support structure- Firmly connects Table top and the U shaped frame.
Our cad model represents a multi-functional table.we made an initial trial design of the table and then improved on its design so as to reduces the maximum equivalent stresses and strains.The above cad model pictures depict the improved as well as the original trial design.The improvements are,table tops structure is changed and the truss structure was made hollow which was originally solid.

SOFTWARES

SOLIDWORKS- Used for the 3d modelling of the multi-functional table.
ANSYS- Used for static structural analysis of the table.

BOUNDARY CONDITIONS

A linearly time varying force,varying from 0 to 25N in 1sec to 60N in next 7sec, is applied on the table top and the frame,to which the table is attached,is statically fixed to the ground.These boundary conditions are applied on the ansys software for the stress-strain analysis.

MATERIAL SPECIFICATION

Properties of Outline Row 3: ABS plastic

	A	B	C
1	Property	Value	Unit
2	Density	1040	kg m^-3
3	⊞ Isotropic Secant Coefficient of Thermal Expansion		
5	⊞ Isotropic Elasticity		
11	Tensile Yield Strength	41.4	MPa
12	Tensile Ultimate Strength	44.3	MPa

Table1:ABS plastic(material used for table top)

Properties of Outline Row 4: Gray Cast Iron

	A	B	C
1	Property	Value	Unit
2	Material Field Variables	Table	
3	Density	7200	kg m^-3
4	⊞ Isotropic Secant Coefficient of Thermal Expansion		
6	⊞ Isotropic Elasticity		
12	Tensile Yield Strength	65	MPa
13	Compressive Yield Strength	65	MPa
14	Tensile Ultimate Strength	240	MPa
15	Compressive Ultimate Strength	8.2E+08	Pa

Table2:gray cast iron(material used for framepart)

Properties of Outline Row 5: Structural Steel

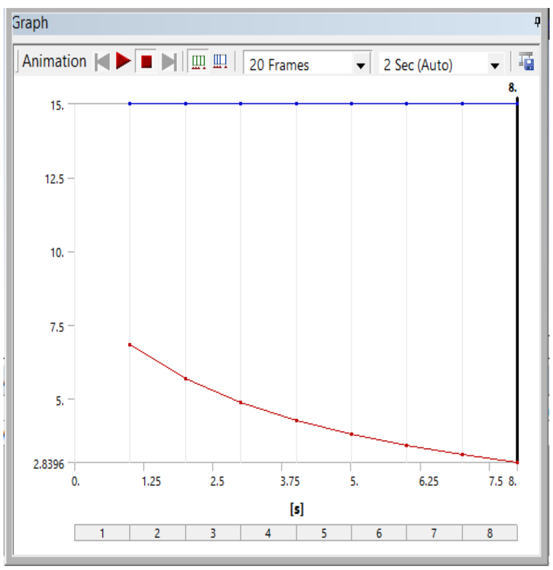
	A	B	C
1	Property	Value	Unit
2	Material Field Variables	Table	
3	Density	7850	kg m^-3
4	⊞ Isotropic Secant Coefficient of Thermal Expansion		
6	⊞ Isotropic Elasticity		
12	⊟ Strain-Life Parameters		
13	Display Curve Type	Strain-Life	
14	Strength Coefficient	920	MPa
15	Strength Exponent	-0.106	
16	Ductility Coefficient	0.213	
17	Ductility Exponent	-0.47	
18	Cyclic Strength Coefficient	1000	MPa
19	Cyclic Strain Hardening Exponent	0.2	
20	⊞ S-N Curve	Tabular	
24	Tensile Yield Strength	250	MPa
25	Compressive Yield Strength	250	MPa
26	Tensile Ultimate Strength	460	MPa
27	Compressive Ultimate Strength	0	Pa

Table3:structural steel(material used for truss support)

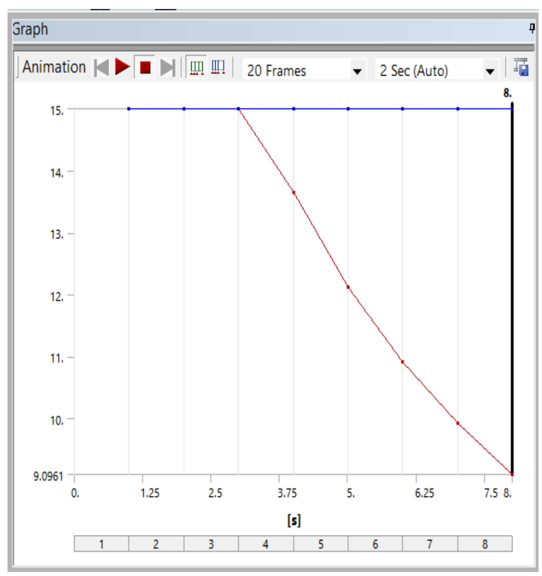
MATHEMATICAL FORMULATION

Factor of safety(fos)=yield stress/von mises stress
With the factor of safety we can check whether the structure can withstand the forces or not .For this fos should be greater than 1 at every point in structure.

CONVERGENT ANALYSIS



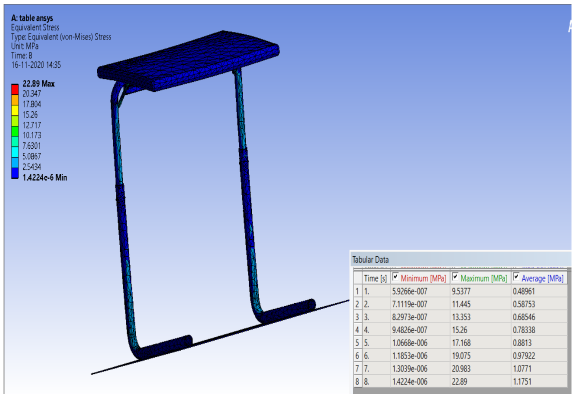
Graph1-curve for FOS for original design



Graph2-curve for FOS for improved design

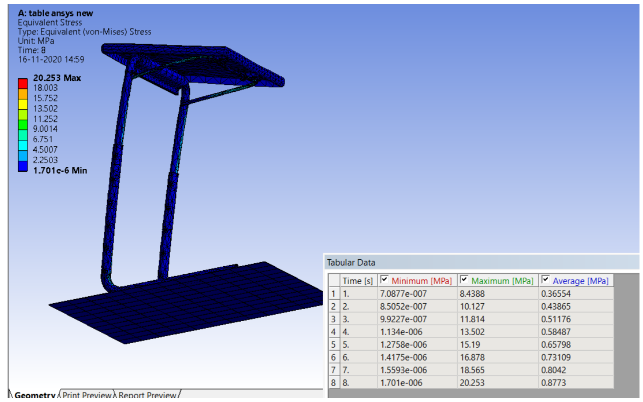
It is clearly visible that the minimum FOS for improved design is far more than FOS of original design .Also FOS for improved design is closer to the maximum factor of safety. So from here it can be said that improved design is much better than the original design

RESULTS



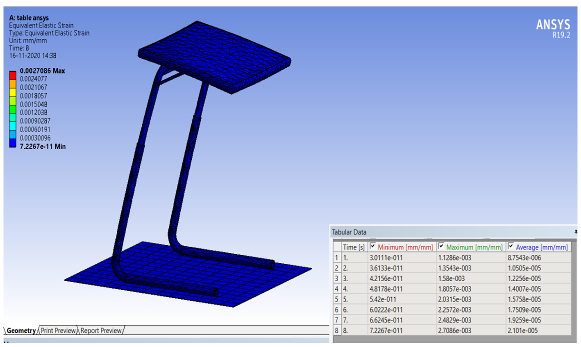
	Time [s]	Minimum [MPa]	Maximum [MPa]	Average [MPa]
1	1.	5.9266e-007	9.5377	0.48961
2	2.	7.1119e-007	11.445	0.58753
3	3.	8.2973e-007	13.353	0.68546
4	4.	9.4826e-007	15.26	0.78338
5	5.	1.0668e-006	17.168	0.8813
6	6.	1.1853e-006	19.075	0.97922
7	7.	1.3039e-006	20.983	1.0771
8	8.	1.4224e-006	22.89	1.1751

FIG1- stress analysis of the original design



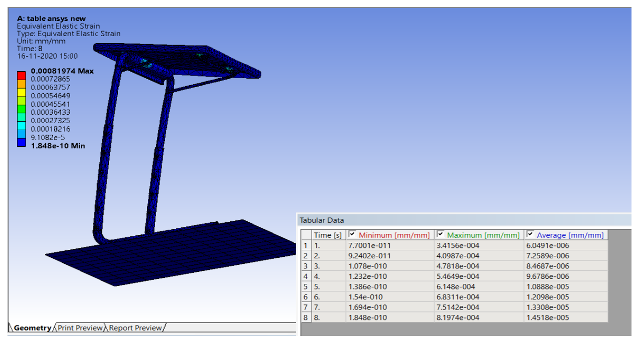
	Time [s]	Minimum [MPa]	Maximum [MPa]	Average [MPa]
1	1.	7.0877e-007	8.4388	0.36554
2	2.	8.5052e-007	10.127	0.43865
3	3.	9.9227e-007	11.814	0.51176
4	4.	1.134e-006	13.502	0.58487
5	5.	1.2758e-006	15.19	0.65798
6	6.	1.4175e-006	16.878	0.73109
7	7.	1.5593e-006	18.565	0.8042
8	8.	1.701e-006	20.253	0.8773

FIG2- stress analysis of the improved design



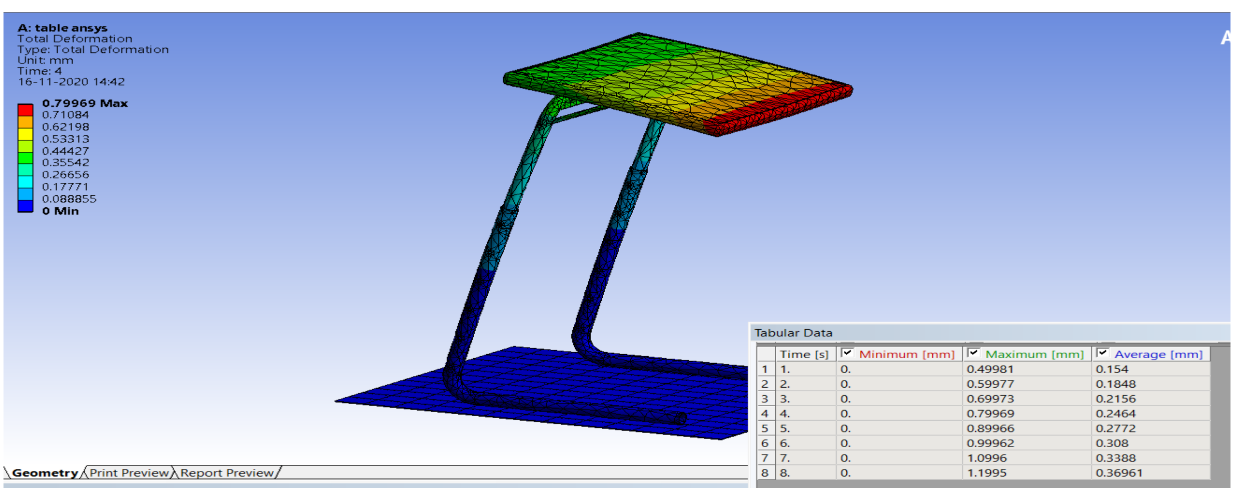
	Time [s]	Minimum [mm/mm]	Maximum [mm/mm]	Average [mm/mm]
1	1.	3.0111e-011	1.1286e-003	8.7543e-006
2	2.	3.6133e-011	1.3543e-003	1.0505e-005
3	3.	4.2156e-011	1.58e-003	1.2256e-005
4	4.	4.8178e-011	1.8057e-003	1.4007e-005
5	5.	5.42e-011	2.0315e-003	1.5758e-005
6	6.	6.0222e-011	2.2572e-003	1.7509e-005
7	7.	6.6245e-011	2.4829e-003	1.9259e-005
8	8.	7.2267e-011	2.7086e-003	2.101e-005

FIG3- strain analysis of the original design



	Time [s]	Minimum [mm/mm]	Maximum [mm/mm]	Average [mm/mm]
1	1.	7.7001e-011	3.4156e-004	6.0491e-006
2	2.	9.2402e-011	4.0987e-004	7.2589e-006
3	3.	1.078e-010	4.7818e-004	8.4687e-006
4	4.	1.232e-010	5.4649e-004	9.6786e-006
5	5.	1.386e-010	6.148e-004	1.0888e-005
6	6.	1.54e-010	6.8311e-004	1.2098e-005
7	7.	1.694e-010	7.5142e-004	1.3308e-005
8	8.	1.848e-010	8.1974e-004	1.4518e-005

FIG4- strain analysis of the improved design



	Time [s]	Minimum [mm]	Maximum [mm]	Average [mm]
1	1.	0.	0.49981	0.154
2	2.	0.	0.59977	0.1848
3	3.	0.	0.69973	0.2156
4	4.	0.	0.79969	0.2464
5	5.	0.	0.89966	0.2772
6	6.	0.	0.99962	0.308
7	7.	0.	1.0996	0.3388
8	8.	0.	1.1995	0.36961

FIG5 - Deformation analysis of original design

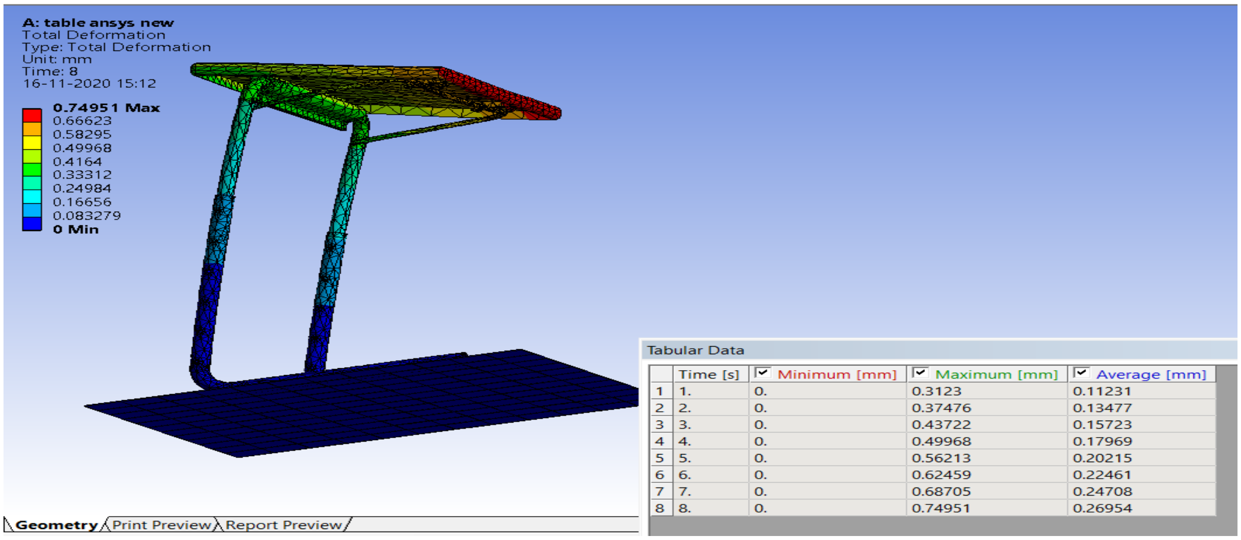
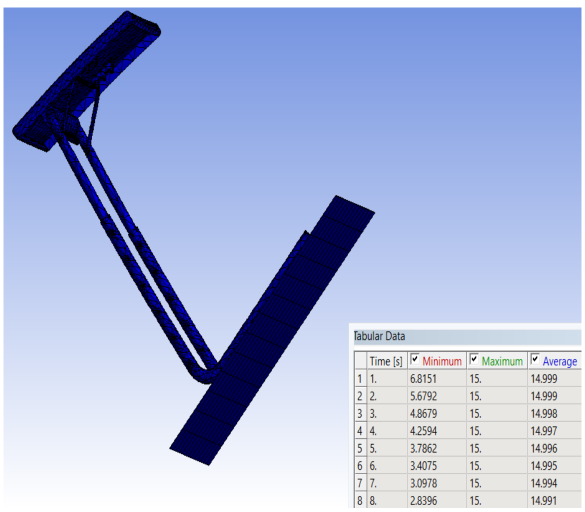


FIG6- deformation analysis of improved design



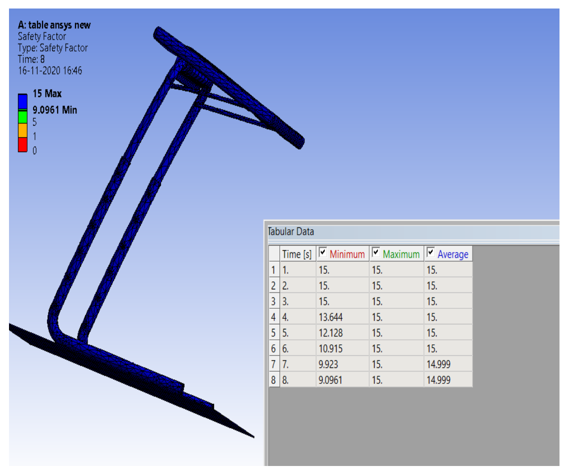
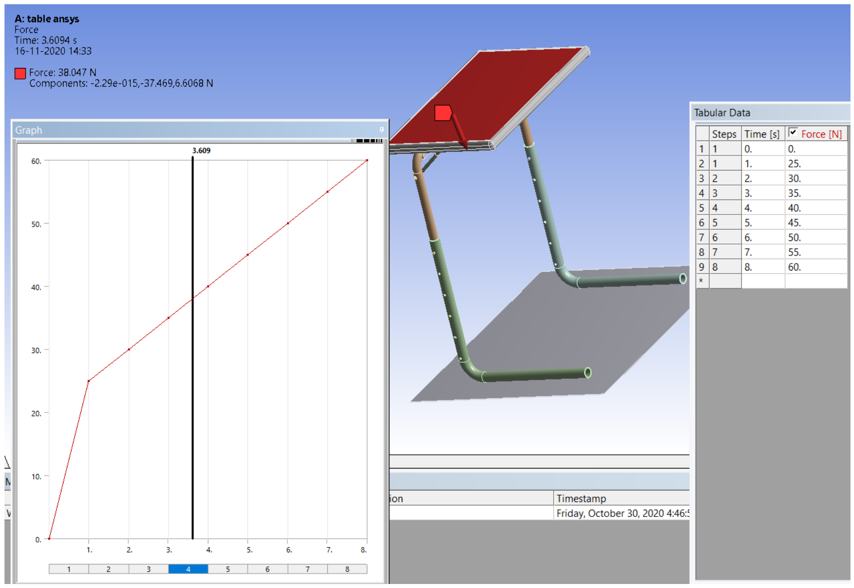


FIG7- Factor of safety of the original design

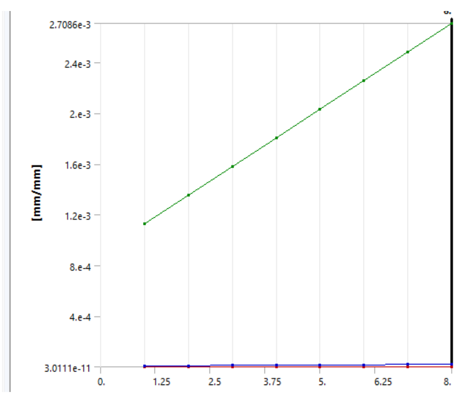
FIG8- Factor of safety of the improved design

The above figures show the stress,strain,deformation analysis of original design and improved design.

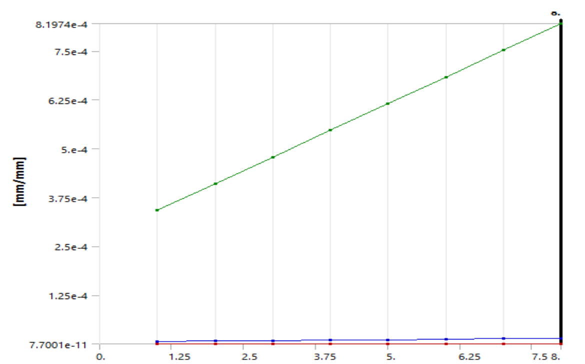
GRAPHS



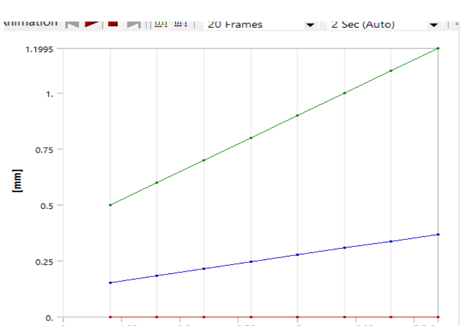
GRAPH1- variation of force wrt to time



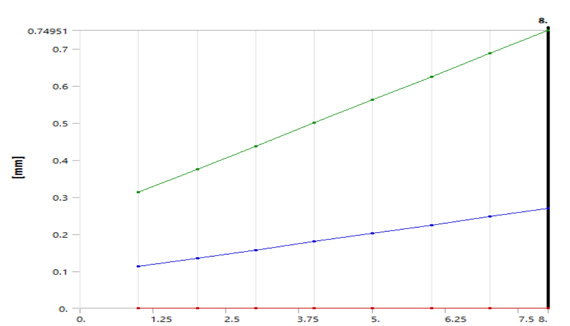
GRA2-stress original vs time



GRA3-stress improved vs time



GRA4-Deformation original vs time



GRA5- deformation improved vs time

DISCUSSION ON RESULTS

The static structural analysis is performed for both the original and improved design and it was evident from the graphs and stress, strain ,deformation analysis figures that the maximum stress, strain and deformation decreased for the improved design.

The maximum stress for the original design was, as evident from the graph,22.89Mpa.
The maximum stress for the improved design was 20.253Mpa.As, we can see the average stresses also reduced in the improved design.

The maximum strain for the original design was, as evident from the graph,2.7086e-3.
The maximum strain for the improved design was 8.197e-4.

The maximum Deformation for the original design was, as evident from the graph,1.1995mm.
The maximum Deformation for the improved design was0.74951mm.

The minimum factor of safety for the original design was, as evident from the graph,2.8398.The minimum factor of safety for the improved design was 9.0961.

CONCLUSION

SOLIDWORKS was used for making the CAD model of the structure. To find and study the different graphs and values of stresses, strains and deformation, analysis of CAD model was done using simulation in ANSYS under various loading conditions.

To increase the durability, strength and resistance against deformation, changes in original design were made on the basis of theories and various graphs and analysing the structure in ANSYS.

With this improved design of CAD model, the maximum deformation decreased, maximum strain and stress decreased under different types of load varying conditions, hence the minimum factor of safety has increased immensely, which led to better and improved design that can fit the common user's requirements with much less probability of failure.

Since the improved factor of safety is 9, So there is scope for topology optimization which can help in reduction of overall weight and also we get a better geometry.

REFERENCE

- https://forum.ansys.com/
- https://books.google.com/books?hl=en&lr=&id=aJKeBgAAQBAJ&oi=fnd&pg=PR5&dq=table+analysis+using+ansys&ots=eWfdcXTsW7&sig=gy9-AMoEi6WVIMWwjVItYup0pQk
- https://books.google.co.in/books/about/SOLIDWORKS_2020_Intermediate_Skills.html?id=sXi-DwAAQBAJ&redir_esc=y
- https://books.google.com/books?hl=en&lr=&id=eiQbBAAAQBAJ&oi=fnd&pg=PP1&dq=static+structural+analysis+using+ansys&ots=XI-2zkviDz&sig=x01GfHjkJ5RIujv4kY2aq6tnZqI
- https://www.google.co.in/books/edition/Stress_Strain_and_Structural_Dynamics/prBSjrXO3eAC?hl=en&gbpv=1&dq=stress+and+strain&printsec=frontcover
- https://www.amazon.in/WAC-Multipurpose-Fold-able-Breakfast-Ergonomic/dp/B089WDDGPZ/ref=sr_1_5?adgrpid=57929306094&dchild=1&ext_vrnc=hi&gclid=CjwKCAjwlID8BRAFEiwAnUoK1d-Z6EbS-ufUOnNT9dhLk8CMwtAB1zOlqjMZVkqkBnKArMnlcB0BLxoCRqoQAvD_BwE&hvadid=362546940603&hvdev=c&hvlocphy=1007743&hvnetw=g&hvqmt=e&hvrand=2305167493141374624&hvtargid=kwd-88226800&hydadcr=21319_1945541&keywords=table+mate&qid=1602232507&sr=8-5&tag=googinhydr1-21
- https://www.youtube.com/watch?v=dN1Ub864wks&list=PLkMYhICFMsGajeARsY7N1t1jhbtMb1poL