Design and Structural Analysis of a Stool

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Table of Contents

Introduction

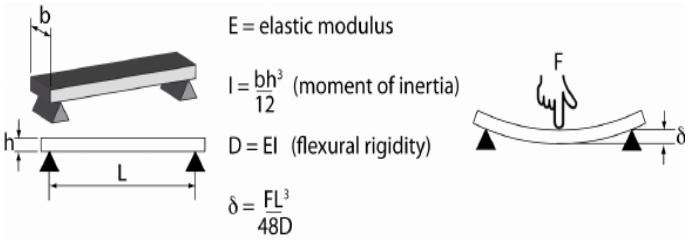
In this project, we will draw a stool and we will make analysis of stool's deflection and factor of safety against a force that exposed from top.We will draw a stool with height of 480 mm and top area is 450x400 mm.

According to drawed solid part, we will find deflection and factor of safety of the stool against a force 1650 N.This part will make from simulation in solidworks.We will explain and show with figures the stages of simulation on the simulation process.

According to simulations, we will check our deflection and factor safety results is bigger or less than we desired.Our desired value of displacement is maximum 8 mm, minimum factor of safety is 4.If material is safe for the desired values we will finish the project succesfully.

Design Process

For bigger strength and lower displacement results of stool, I drawed the stool legs from the center of edges, not from the corners.The reason is, according to the formula, we can see displacement is equal to "$\delta = \frac{F.L^3}{48.E.I}$".

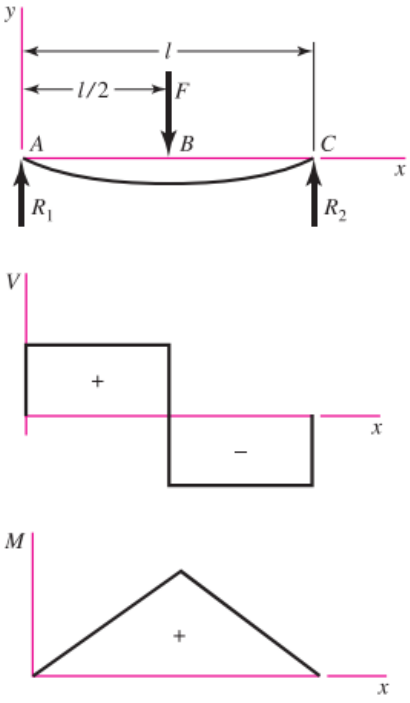


So we can say, if we can change "L(Lenght)", we can get a lower displacement value.So if we choose the "L" from center of the edge to the other center of the edge, we can get less "L" value and as a result we can get less displacement value as we we desired.

Table A–9

Shear, Moment, and Deflection of Beams *(Continued)*
(*Note:* Force and moment reactions are positive in the directions shown; equations for shear force V and bending moment M follow the sign conventions given in Sec. 3–2.)

5 Simple supports—center load



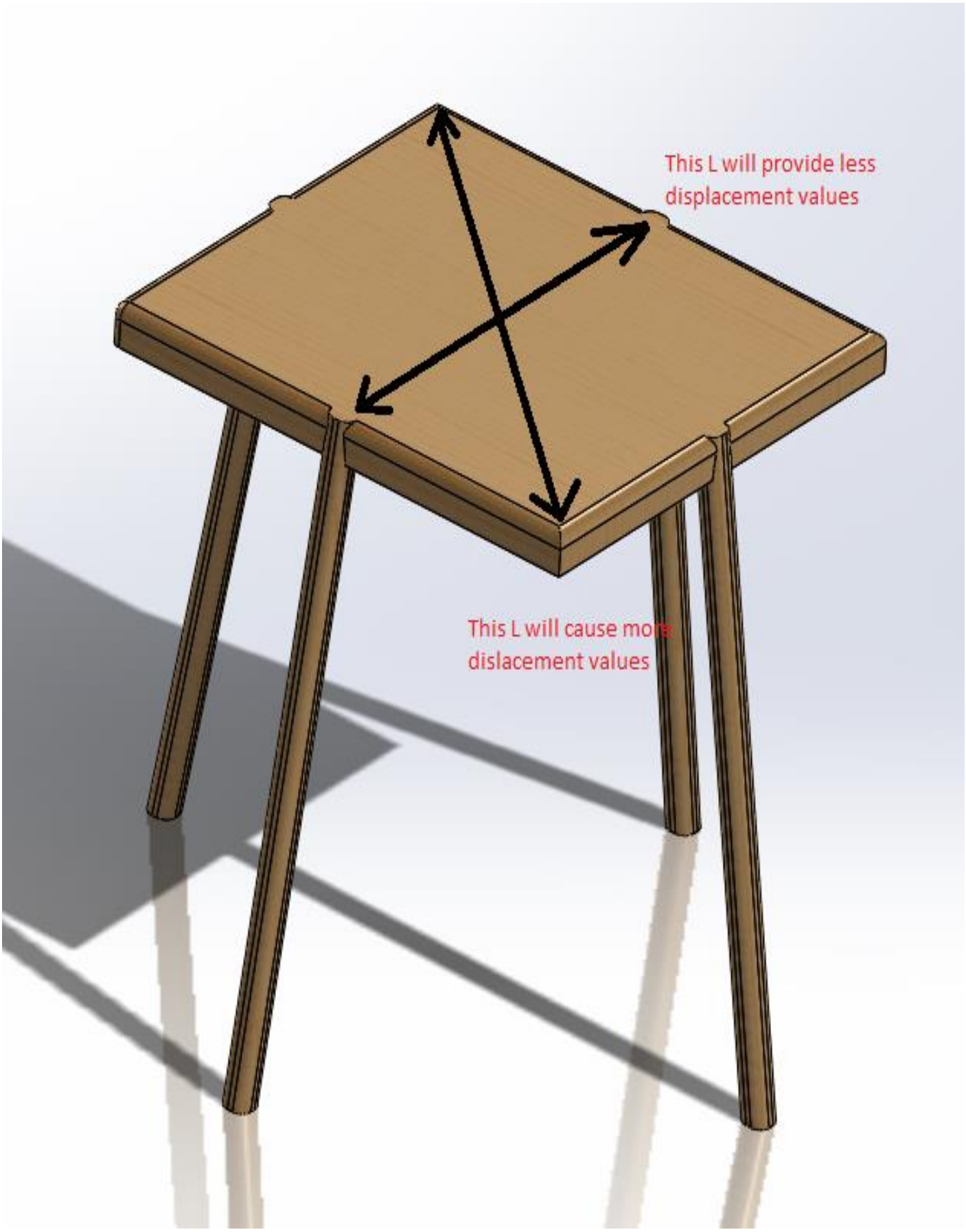
$$R_1 = R_2 = \frac{F}{2}$$

$$V_{AB} = R_1 \qquad V_{BC} = -R_2$$

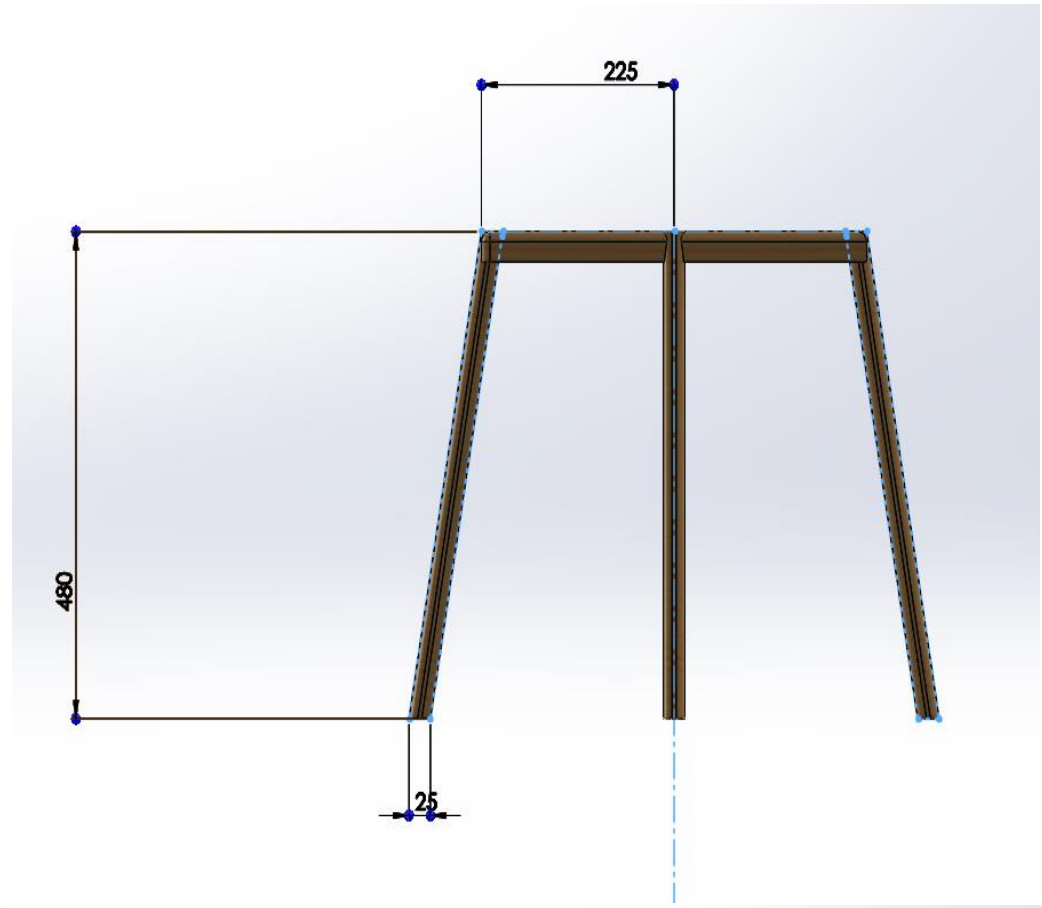
$$M_{AB} = \frac{Fx}{2} \qquad M_{BC} = \frac{F}{2}(l - x)$$

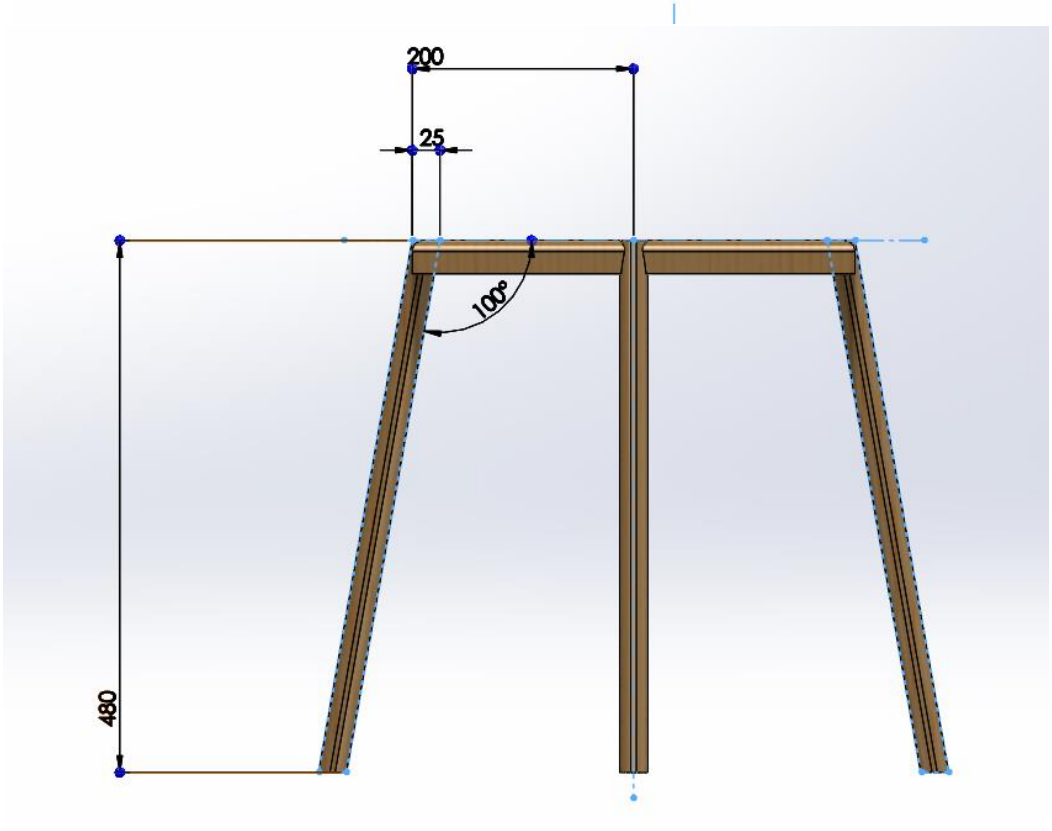
$$y_{AB} = \frac{Fx}{48EI}(4x^2 - 3l^2)$$

$$y_{max} = -\frac{Fl^3}{48EI}$$

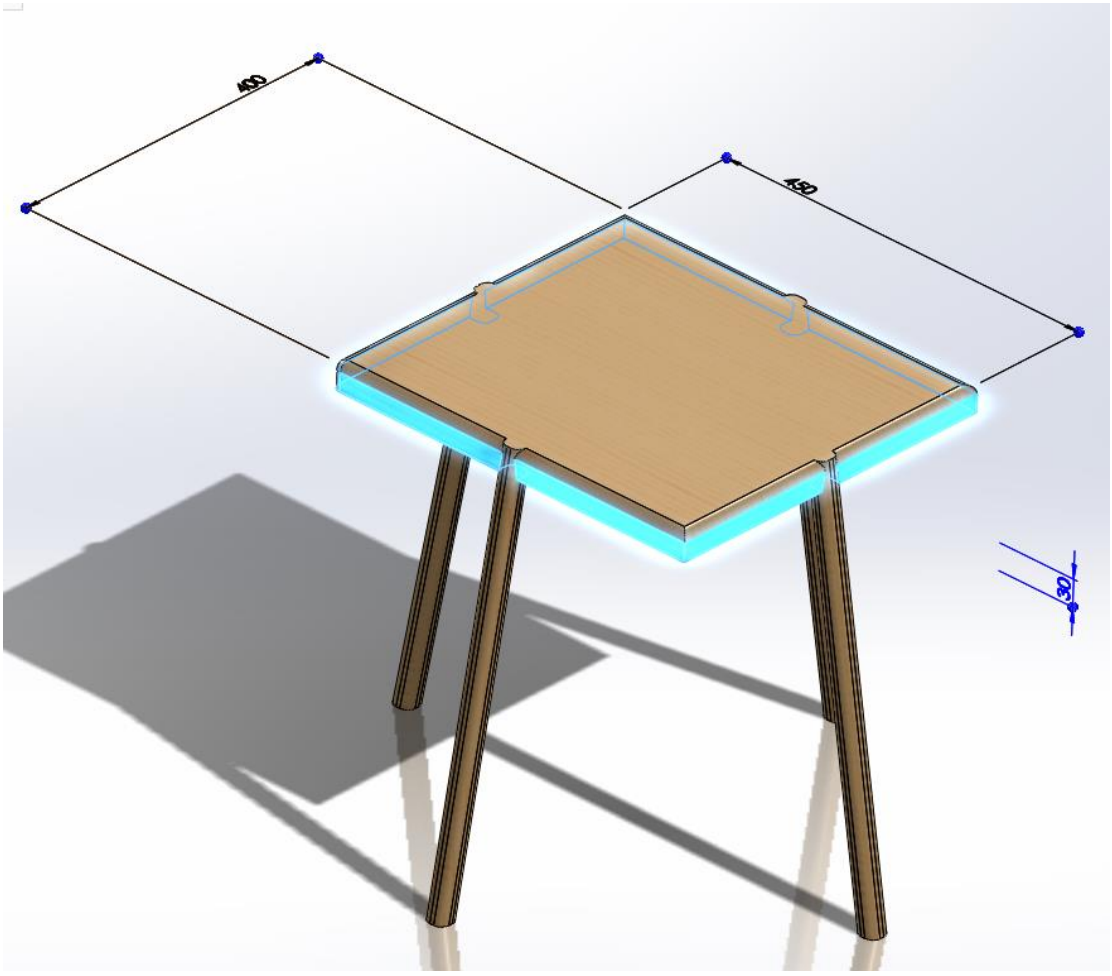

This L will provide less displacement values
This L will cause more dislacement values

You can see the design stages here:





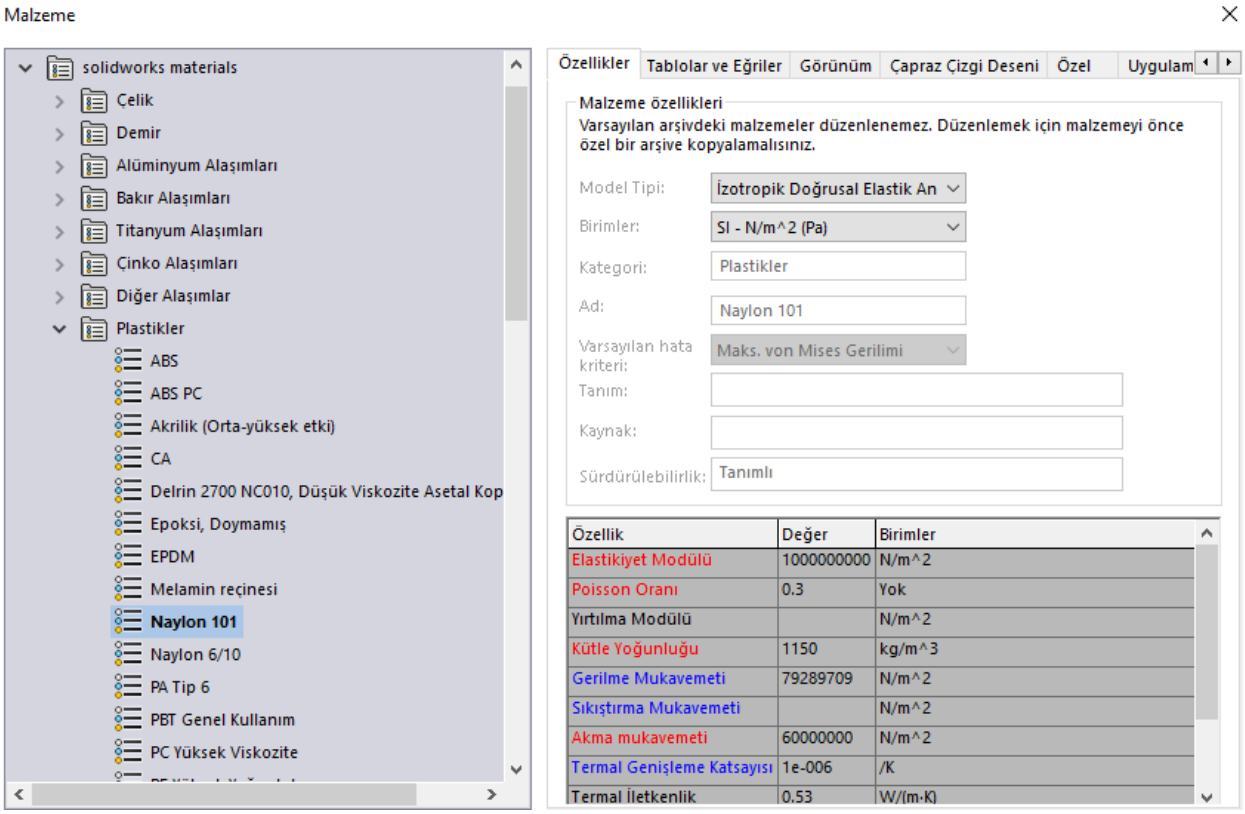
For the design of stool legs, we drawed only one leg and we drawed a center line and we made mirror drawed part with a distance 200 mm and 225 mm from the center line,respectively.

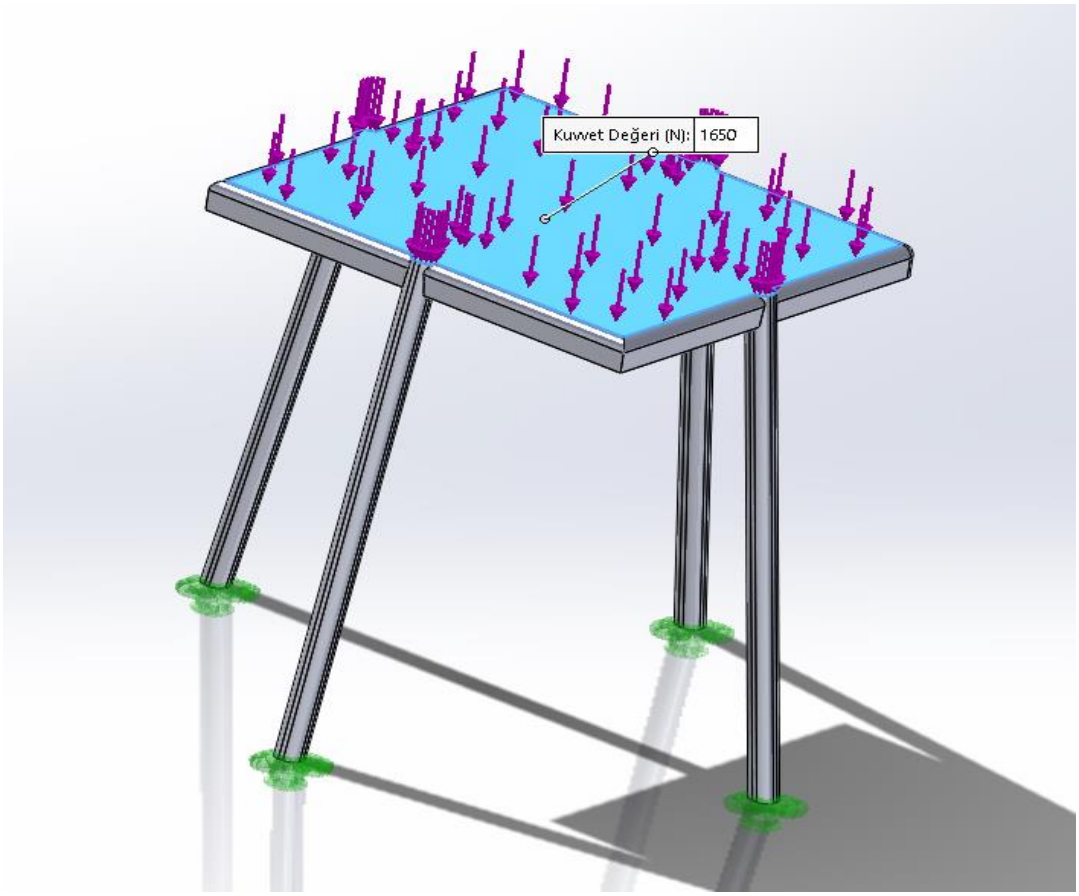


For the top of stool, we extruded from the top of the stool legs with a thickness of 30 mm and area is 450x400 mm.

Displacement and Factor of Safety Analysis

For the analysis of displacement and factor of safety, we used Solidworks Simulation program.We will explain our process with figures stage by stage.

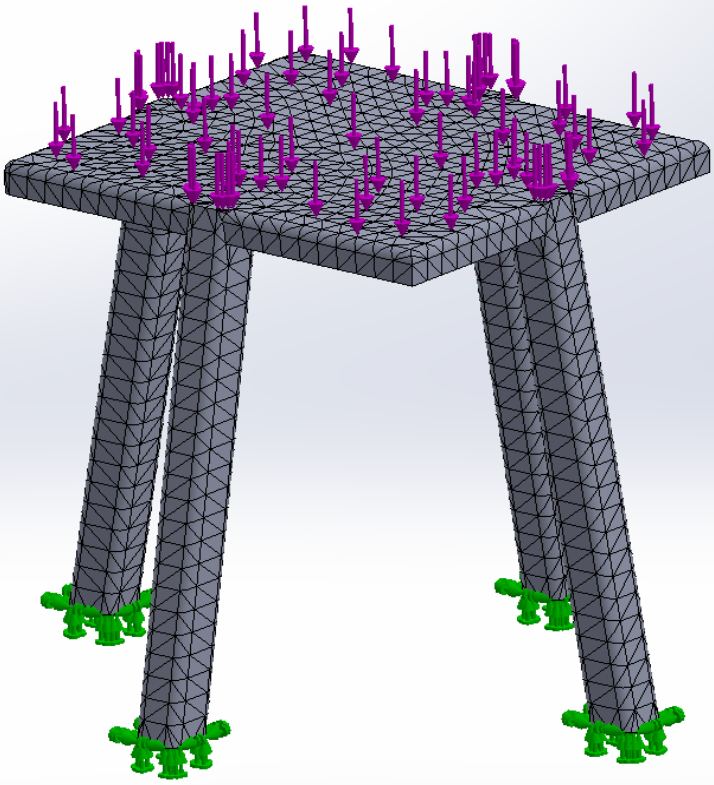




Model adı:Parça2
Etüt adı:Static 1(-Varsayılan-)
Mesh tipi: Katı Mesh

Mesh Detaylar

Etüt adı	Static 1 (-Varsayılan-)
Mesh tipi	Katı Mesh
Kullanılan Meshleyici	Standart
Otomatik Geçiş	Kapalı
Mesh Otomatik Döngülerini Ekle	Kapalı
Jakoben noktalar	4 nokta
Eleman boyutu	21.0114 mm
Tolerans	1.05057 mm
Mesh kalitesi	Yüksek
Toplam düğüm	14788
Toplam eleman	8243
Maksimum En Boy Oranı	6.9306
En Boy Oranı < 3 olan elemanların yüzdesi	98.2
En Boy Oranı < 10 olan elemanların yüzdesi	0
Şekli bozulmuş elemanların (Jakoben) %	0
Mesh tamamlama süresi (sa:dk:sn)	00:00:01
Bilgisayar adı	EMRAH



Parça2 öğesinin kütle özellikleri
Konfigürasyon: Varsayılan
Koordinat sistemi: -- varsayılan --

Yoğunluk = 0.00 gram / milimetre küp

Kütle = 9270.69 gram

Hacim = 9270686.95 milimetre küp

Yüzey alanı = 718378.83 milimetrekare

Kütle merkezi: (milimetre)
X = 0.01
Y = -15.83
Z = -0.01

Birincil atalet eksenleri ve birincil eylemsizlik momentleri: (gram * milimetrekare)
Kütle merkezinden alınmış.
Ix = (1.00, 0.00, 0.00) Px = 363260354.42
Iy = (0.00, 1.00, 0.00) Py = 376010258.14
Iz = (0.00, 0.00, 1.00) Pz = 404891808.52

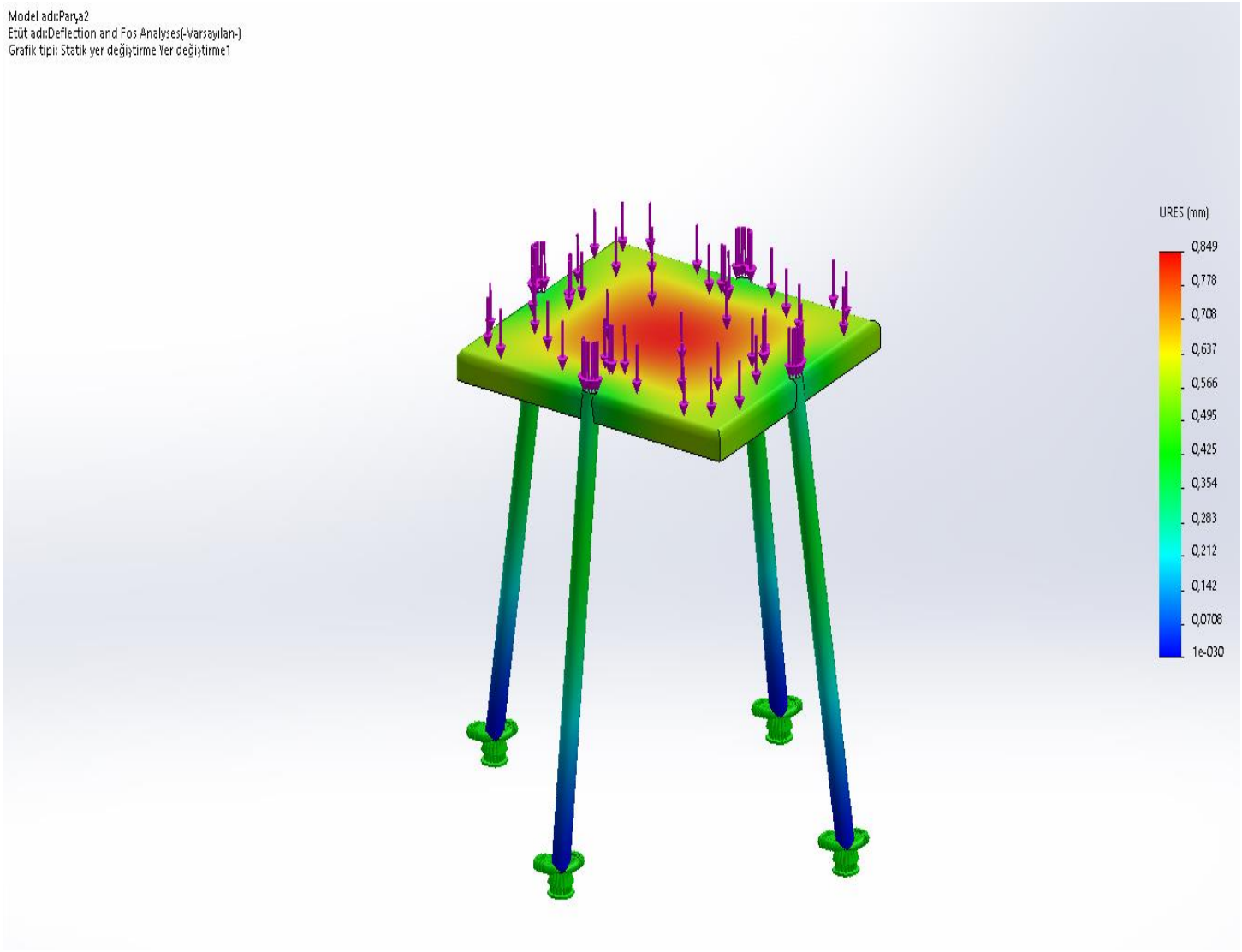
Atalet momenti: (gram * milimetrekare)
Kütle merkezinden alınmış ve çıktı koordinat sistemi ile hizalanmış.

Lxx = 363260382.58	Lxy = 12601.26	Lxz = 25579.25
Lyx = 12601.26	Lyy = 376010250.02	Lyz = -155.96
Lzx = 25579.25	Lzy = -155.96	Lzz = 404891788.49

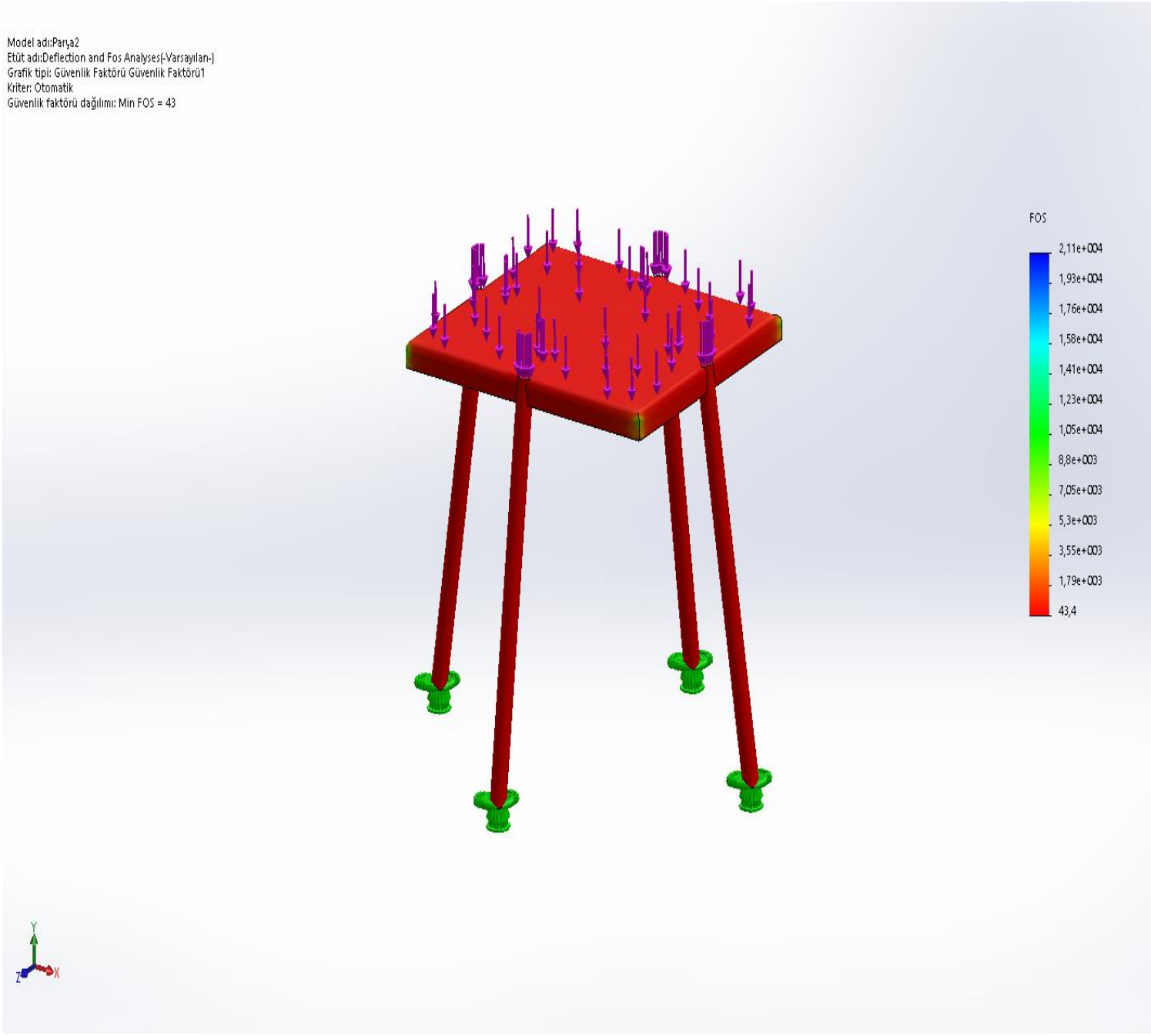
Atalet momenti: (gram * milimetrekare)
Çıktı koordinat sisteminden alınmış.

Ixx = 487647309.32	Ixy = -2817.80	Ixz = 25577.65
Iyx = -2817.80	Iyy = 376010253.27	Iyz = 1740.72
Izx = 25577.65	Izy = 1740.72	Izz = 529278715.80

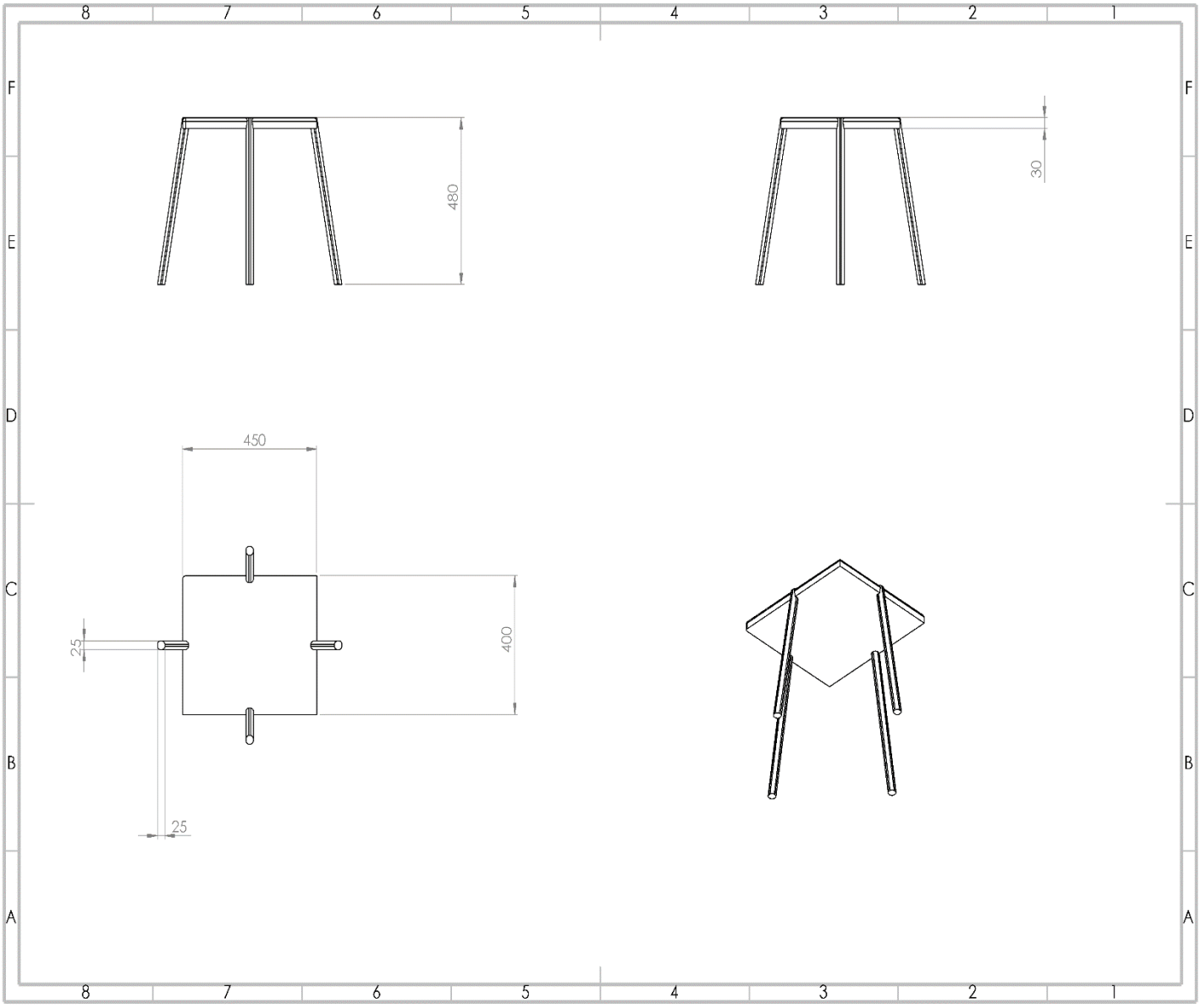
After all this processes, we run the simulation and we got this results;



Model adı:Parça2
Etüt adı:Deflection and Fos Analyses(-Varsayılan-)
Grafik tipi: Güvenlik Faktörü Güvenlik Faktörü1
Kriter: Otomatik
Güvenlik faktörü dağılımı: Min FOS = 43



Technical Drawing



Conclusion

In this project, we drawed a stool and we determined the displacement and factor of safety against a force 1650N from the top.We drawed the legs on the center of the edges.Because if we draw the legs on the corner, we would get more displacement value cause of the bigger “L(Length)” distance.

For the determining displacement and factor of safety, we used Solidworks Simulation.After determining material type we selected the force quantity and location. After running the simulation, we get a displacement value of O.849 mm.Our result is less than 8 mm so our first result was succesfull.Our minimum factor of safety is 43 and its greater than our desired minimum safety factor 4.So our second result was successfull too.

Finally, in this project we developed our Solidworks Simulation skills and we detaily made analysis about the finding materials safeties according to the our drawings and material type.As an engineer, now we don’t need to make strenght analysis manually.