# ANALYSIS OF BED PLATE OF LASER CUTTING MACHINE

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Here it is seen that the Bed Plate which is used in the conventional Laser Cutting machine has the simple Lay-out. Here there is nothing special in the design of Bed Plate but the simple section is there. Due to this conventional design there are some problems arises. To remove these problems it is advisable to optimize or modify the design of the Bed Plate. To modify the design first the analysis of the conventional design should be done & after this the proper modifications in the design should be taken. Now in following pages the conventional design is shown & after that the analysis will be done.



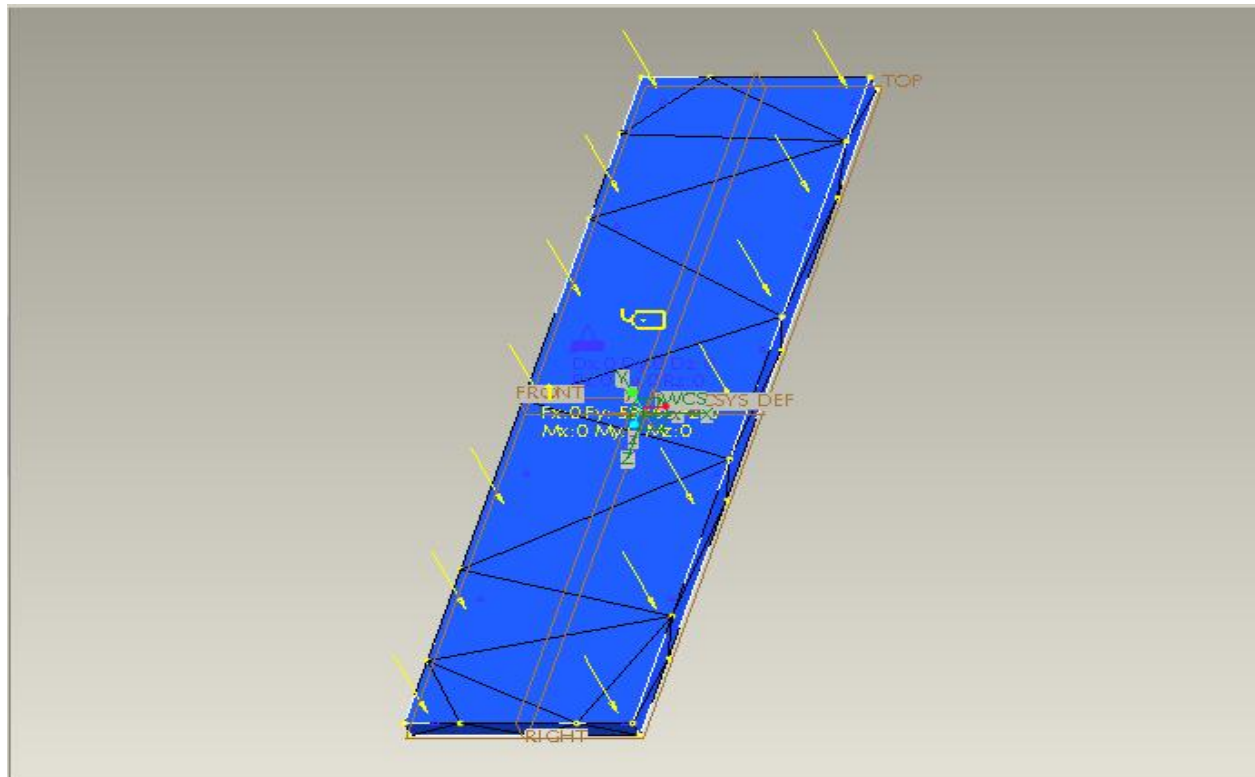*Laser Cutting Machine with Bed Plate*
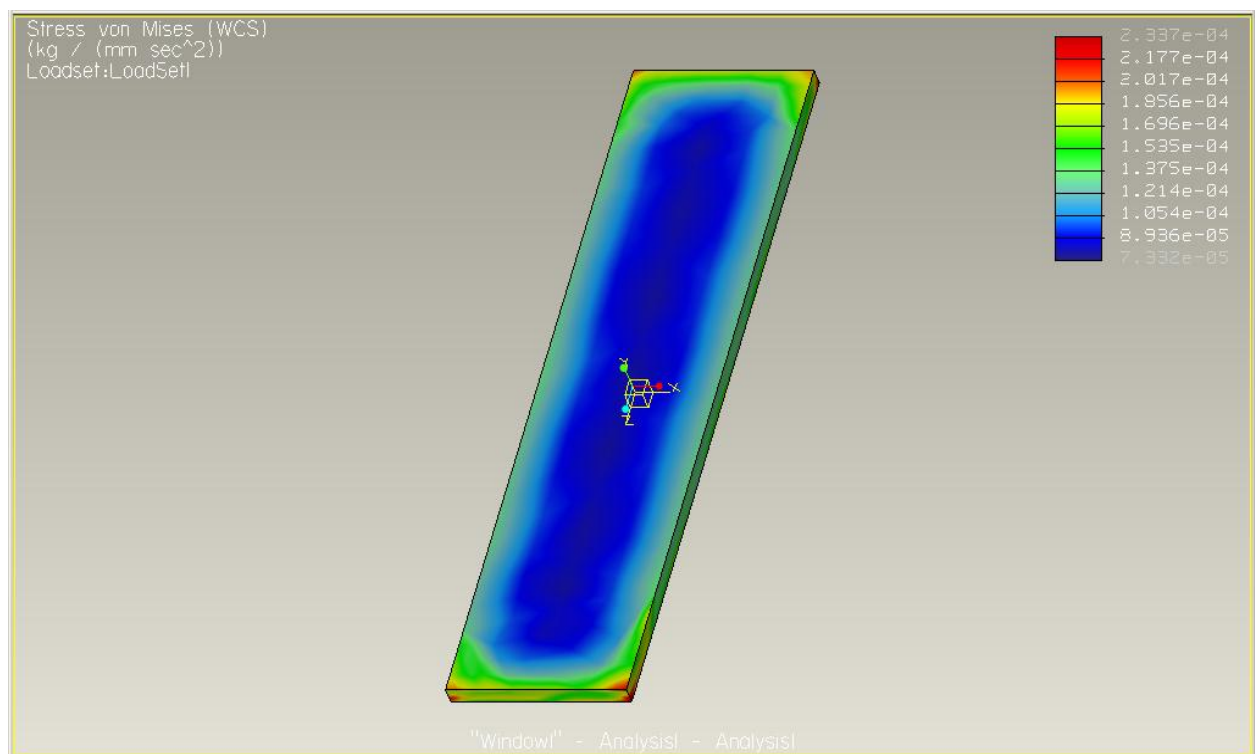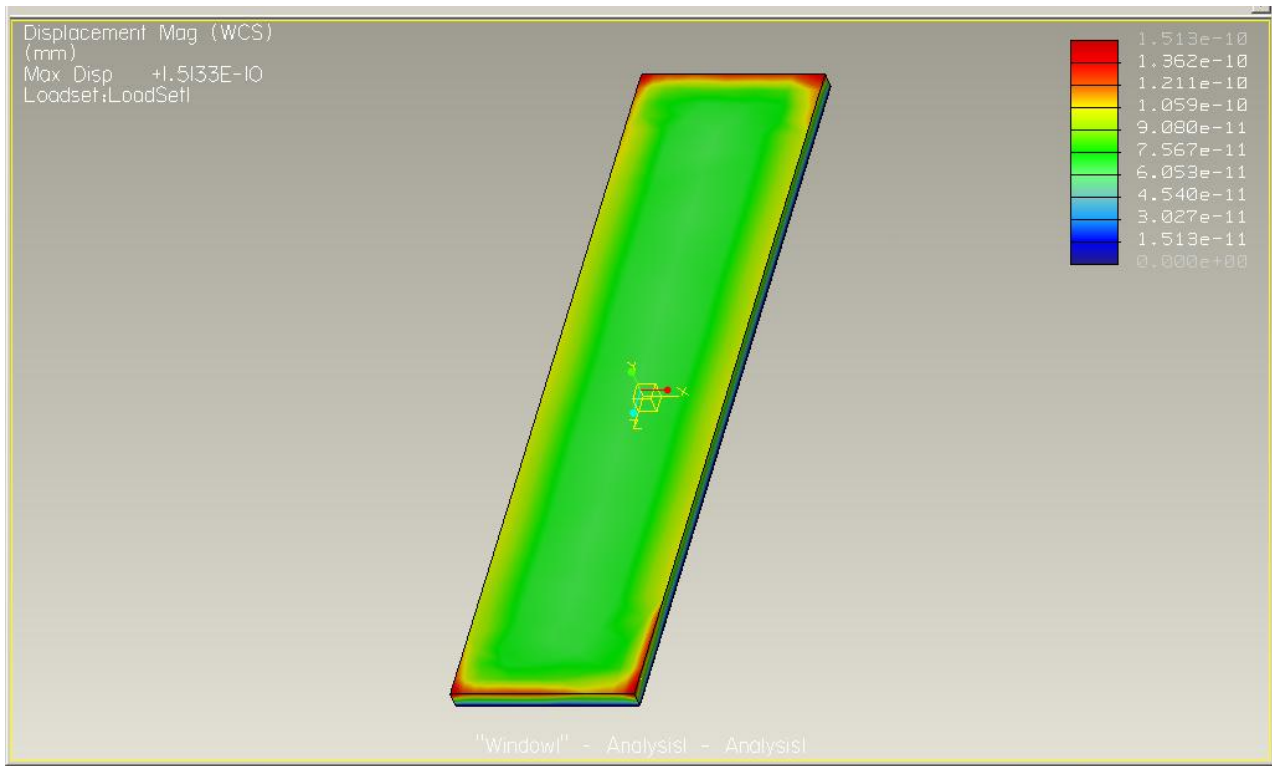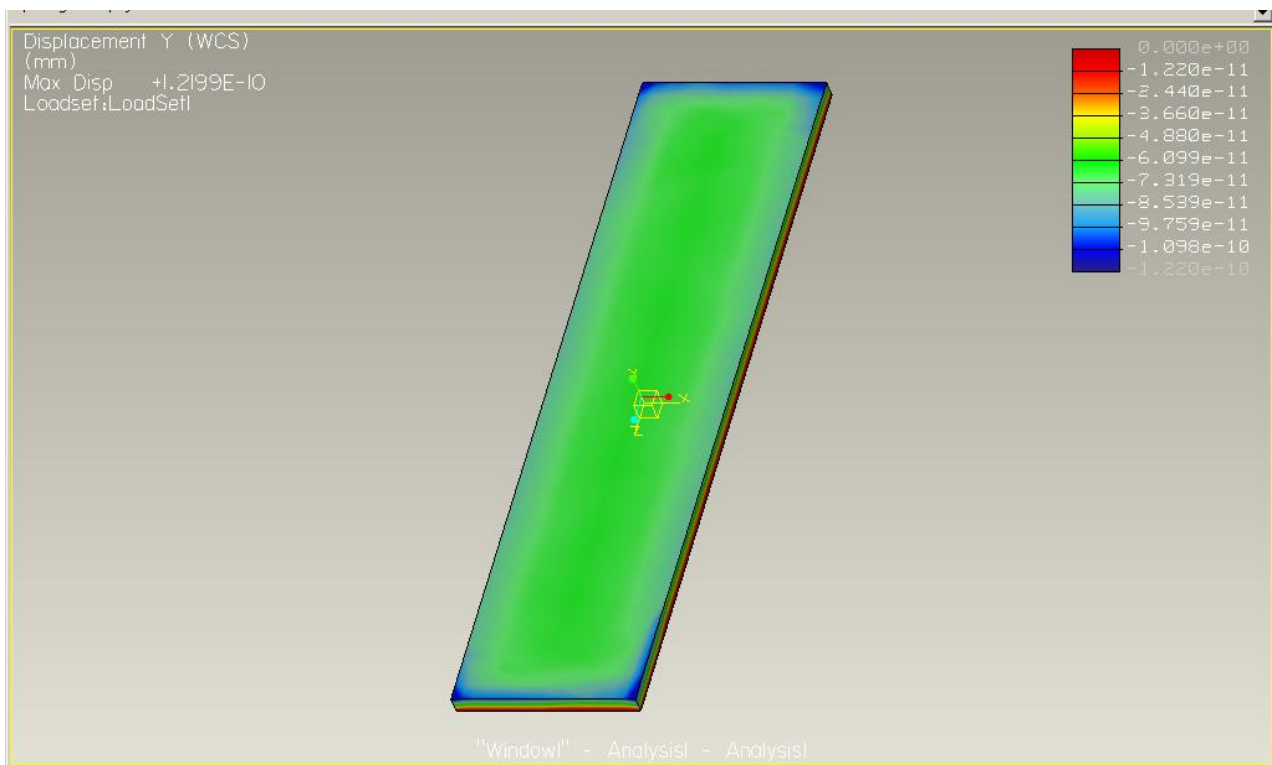
**Analysis of Simple Bed Plate :**

Plate with Meshing



Result: The Maximum VonMises Stress applied on the component is less than 2.337e-04 kg/(mm sec^2). This stress is below the limit of 3.0e-04 kg/(mm sec^2) so it is acceptable.

Result: The Maximum Displacement of the component is about 1.513e-10 mm. This Displacement is below the limit of 5.0e-10 mm so it is acceptable.



Result: The Maximum Displacement of the component at Y is about 1.2199e-10 mm. This Displacement is below the limit of 5.0e-10 mm so it is acceptable.

## ✑  Limitations of Conventional Design :

As seen in above figures, it is clear that the conventional design having no problem with the Stresses & Displacement; it means it is safe as per the requirement but then after there are some problems or limitations for this design. Some of the problems are in the following list.

➢ The upper surface where the sheet metal to be cut or work piece placed is smooth so there is a possibility of cold welding between sheet metal & the Bed Plate.

➢ Due to direct contact of the upper surface to the work piece, there is large possibility of wear of the surface.

➢ If the wearing of the surface is more than the limit, the whole plate must be replaced which is some what costly.

➢ Due to adhere of surface of plate with the work piece, it is very difficult to handle the work piece during loading & unloading.

➢ In some condition when there is a need of a small manual movement of work piece at that time it is very difficult to tackle.

➢ Special arrangement or device must be used for the unloading of the work piece.

➢ Due to direct connection of surface of plate with the work piece, some times the temperature rise of work piece may affect the whole plate due to conduction.

To solve the above problems some modification in the design of the Bed Plate is very necessary & advisable.

The solution of these problems is to modify the upper surface with some embossing. For that the Zig-Zag embossing is the best alternate. Due to Zig-Zag embossing there is a creation of gap between plate & work piece, it means the direct contact between these two surfaces is limited upto the portion of Zig-Zag.

Due to this modification in design following solutions of above problem are done:

➢ Cold welding between two surfaces can be removed
➢ The wear rate of Bed Plate is reducing in large proportion.
➢ When wear is there only the Zig-Zag portion can be replaced & no need to replace the whole Plate.
➢ Comparatively easy to handle during loading & unloading.
➢ Small manual movement is possible because of very less adhere.
➢ There is layer of air between plate & work piece so, heat transfer rate is minimized in large moment.

## ✑  Definition of the Problem :

As discussed in the previous section the plate should be with Zig-Zag portion. Now the question is which material should be used for this plate. Initially the dimension of the Bed Plate is taken from the Laser Cutting Machine "**DH-1812**" of the Cincinati Pvt. Ltd. as shown in figure 9.1

As shown in the figure 9.4 in the following page, the Bed Plate of the Laser Cutting Machine is shown. The dimension of the plate is fixed. On this Plate the work piece Sheet is placed. So the main load is applied on this Plate only. So, the goal is to think about the material used for this plate. To optimize & select the best material the Stress analysis of the plate should be done.

The Plate is having the dimension of 3360 mm x 850 mm x 80 mm. The plate is made by joining the 24 blocks of same dimensions. Each block is having the dimension of 140 mm x 850 mm x 80 mm.
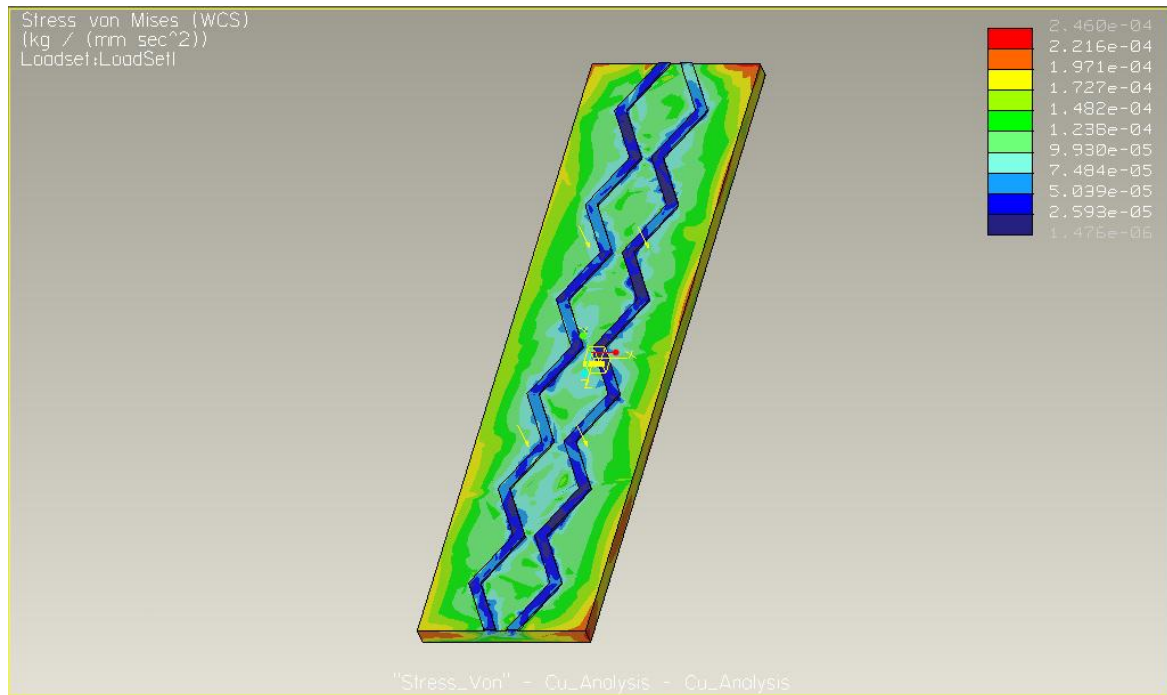
On this plate the Zig-Zag section is clamped which is 43˙ angle with the perpendicular section of the Plate.

Now one by one we will analyze the plate by taking the different materials for the plate & find the optimized material by taking the parameters of Stress, Displacement & Cost of the material.
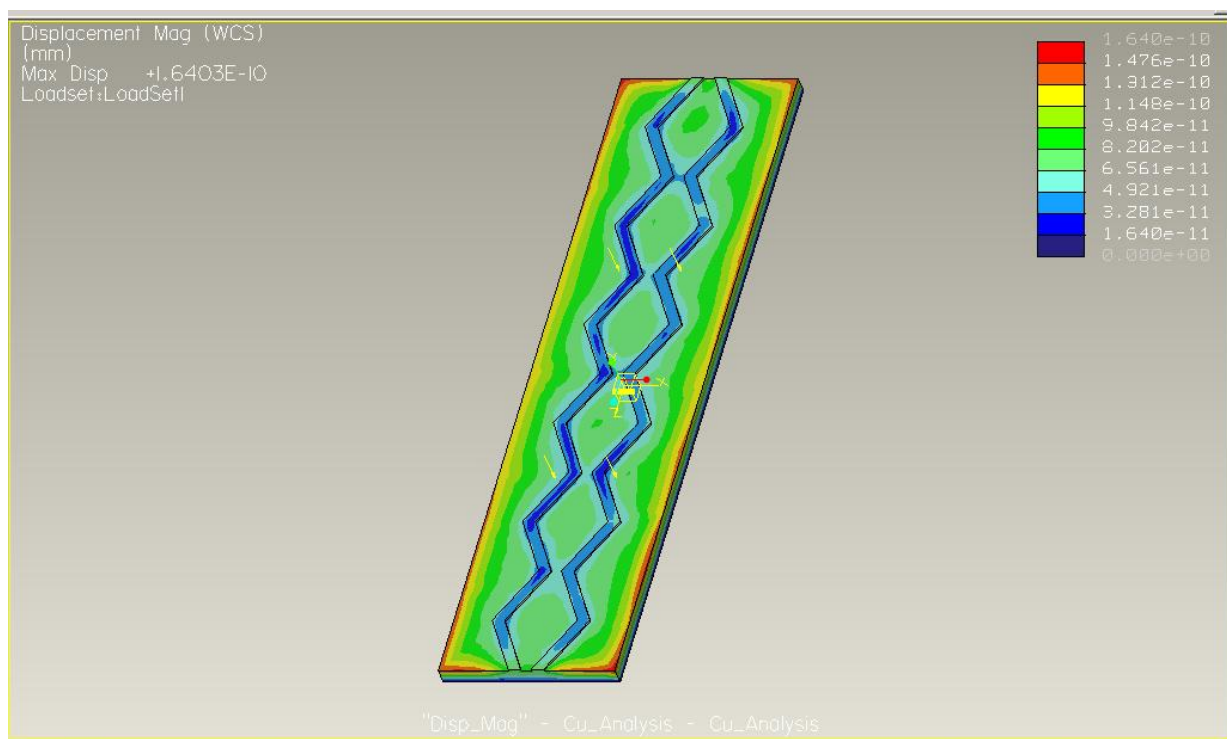
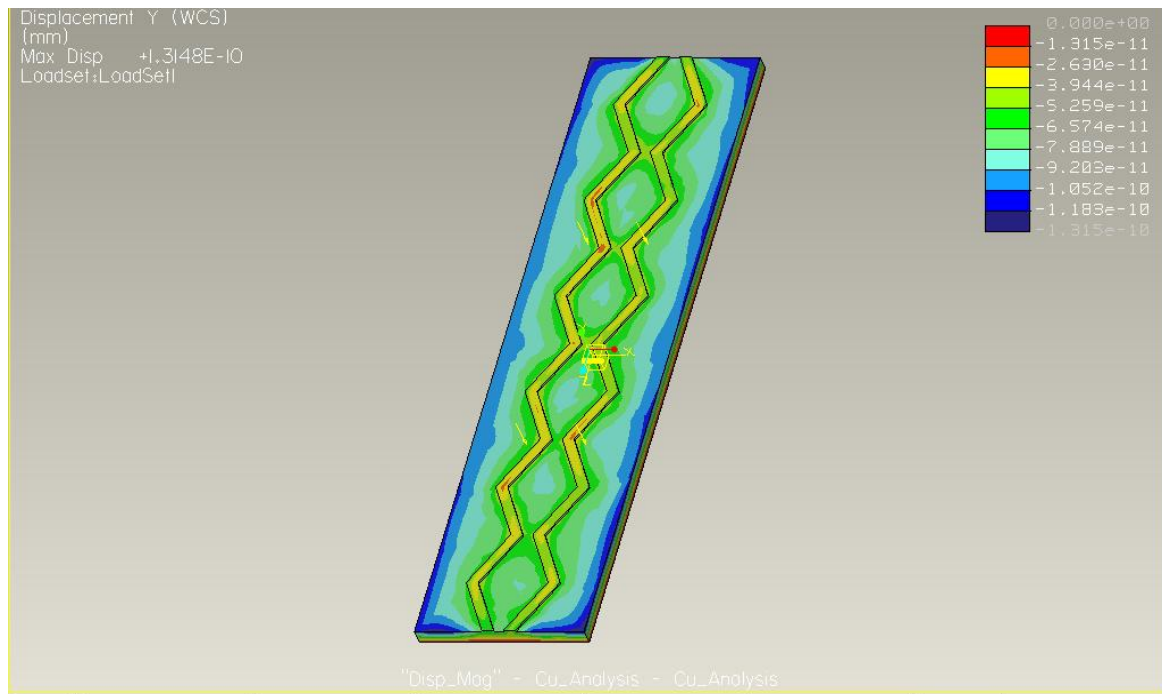**Analysis of Bed Plate with Modified Design :**

Material: COPPER



Result: The Maximum VonMises Stress applied on the component is less than 2.460e-04 kg/(mm sec^2)This stress is below the limit of 3.0e-04 kg/(mm sec^2)so it is acceptable.
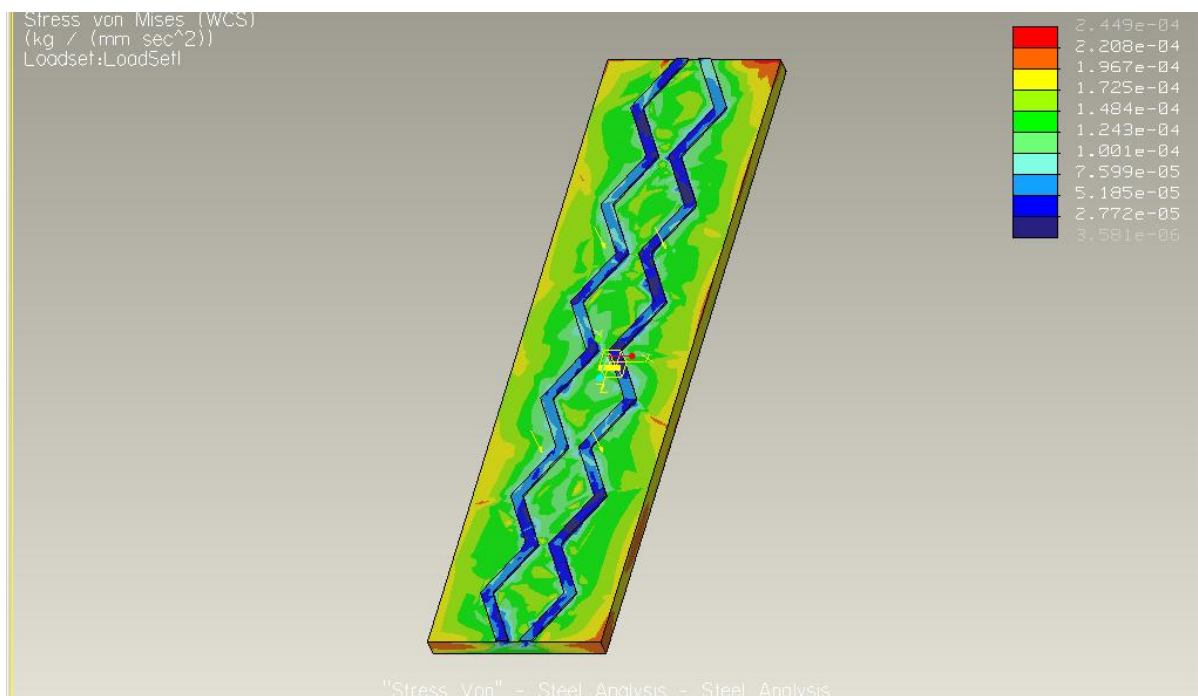
Result: The Maximum Displacement of the component is about 1.6403e-10 mm. This Displacement is below the limit of 3.0e-10 mm so it is acceptable.
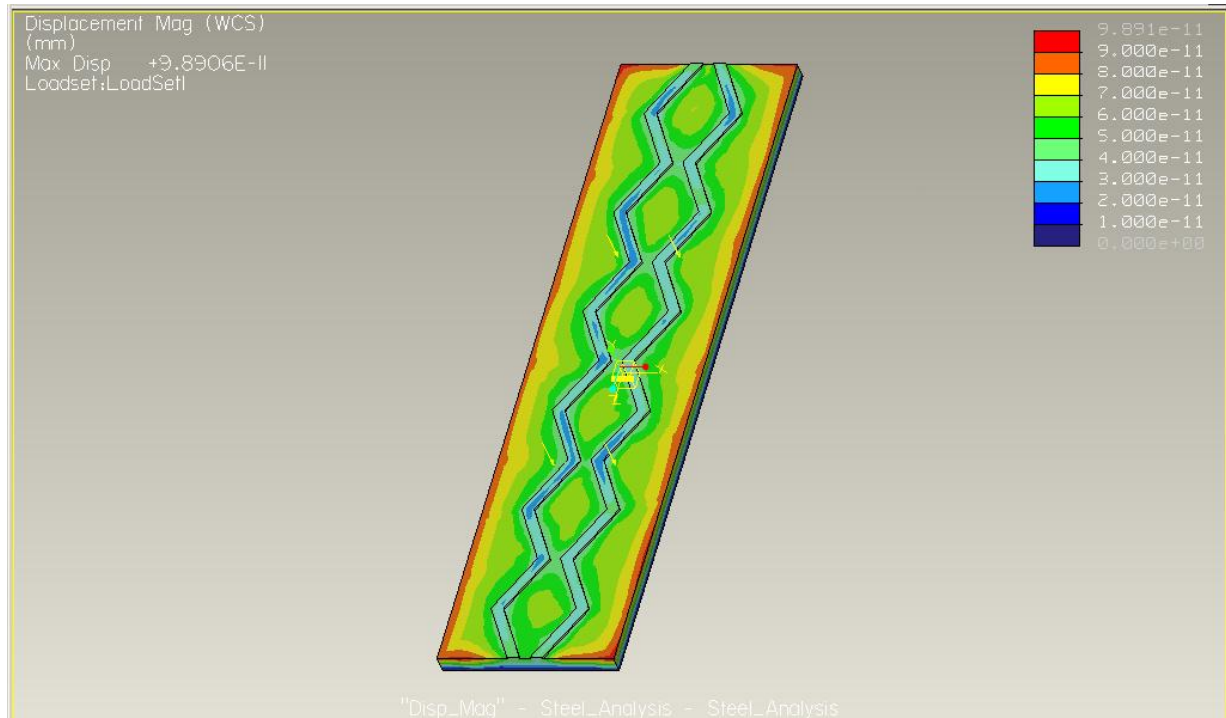


Result: The Maximum Displacement of the component at Y is about 1.3148e-10 mm. This Displacement is below the limit of 3.0e-10 mm so it is acceptable.
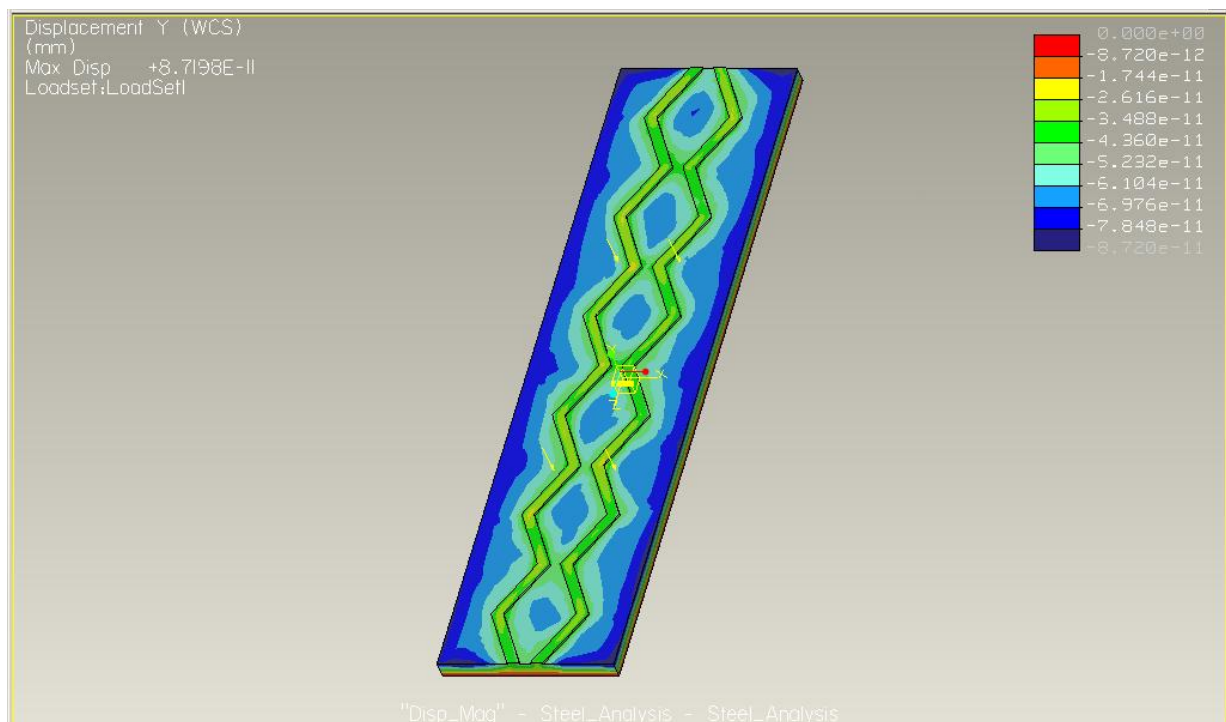
Material: STEEL



Result: The Maximum VonMises Stress applied on the component is less than 2.449e-04 kg/(mm sec^2). This stress is below the limit of 3.0e-02 kg/(mm sec^2) so it is acceptable.

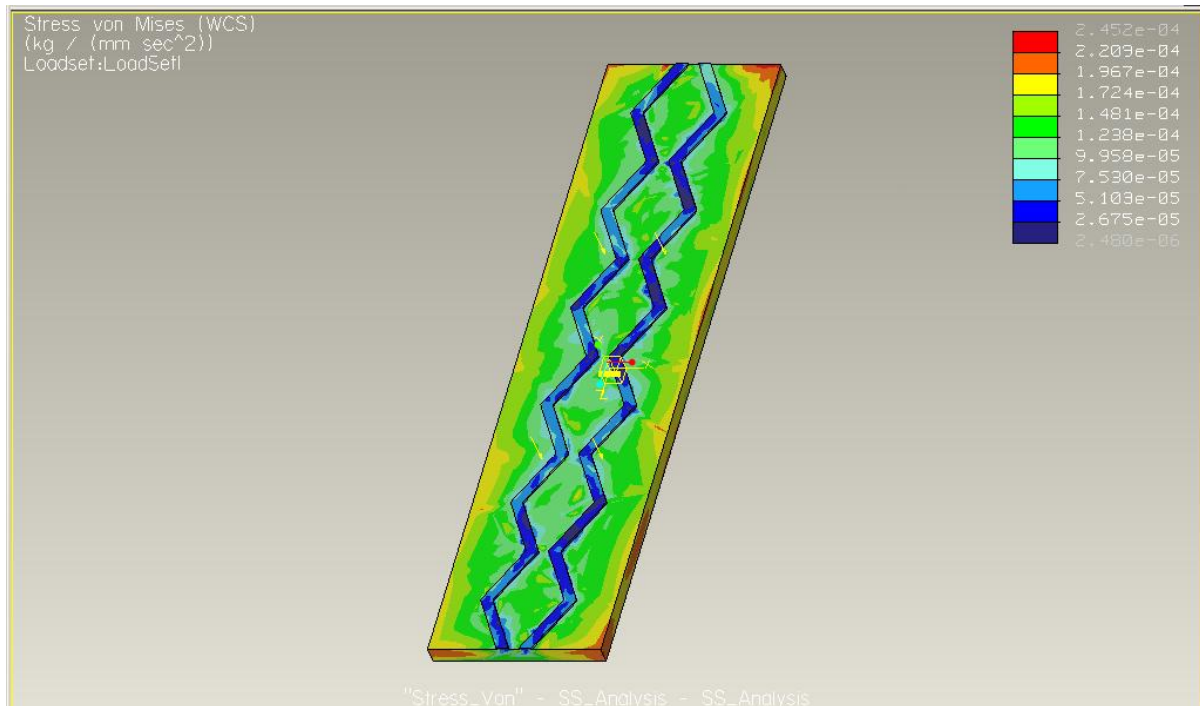<u>Result</u>: The Maximum Displacement of the component is about 9.890e-11 mm. This Displacement is below the limit of 3.0e-10 mm so it is acceptable.
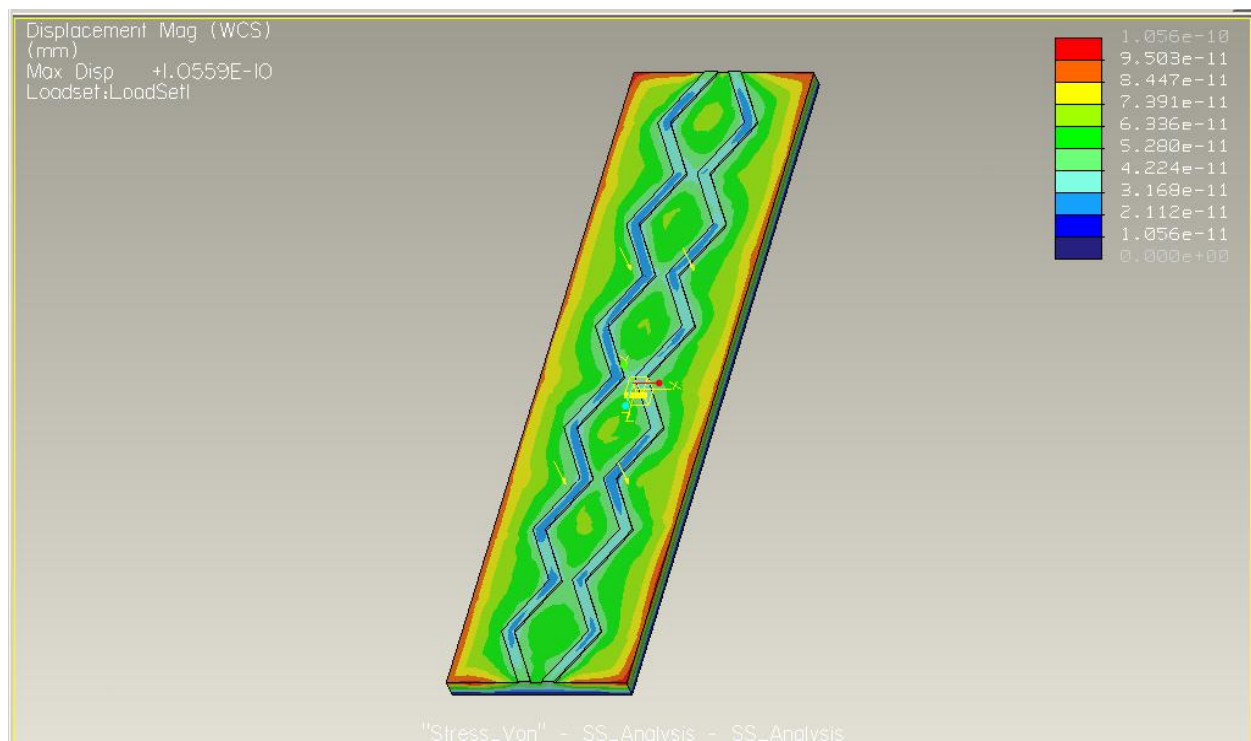


<u>Result</u>: The Maximum Displacement of the component at Y is about 8.7198e-11 mm. This Displacement is below the limit of 3.0e-10 mm so it is acceptable.
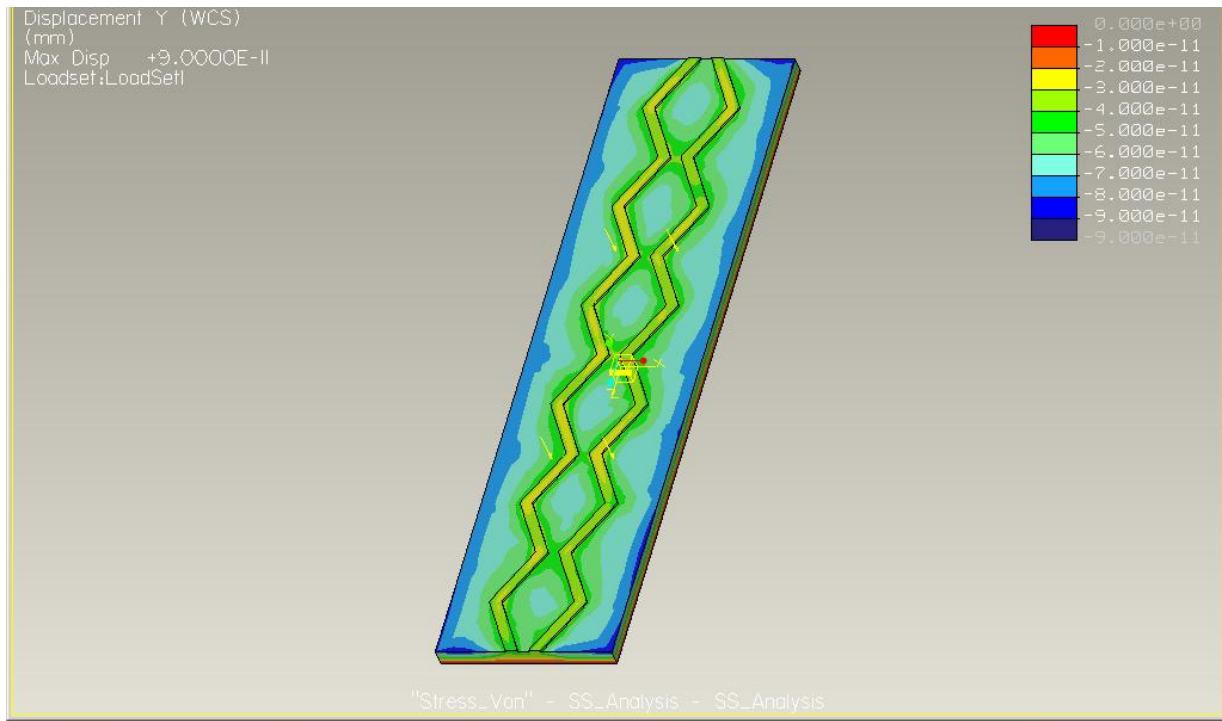
Material: STAINLESS STEEL



Result: The Maximum VonMises Stress applied on the component is less than 2.452e-04 kg/(mm sec^2). This stress is below the limit of 3.0e-02 kg/(mm sec^2)so it is acceptable.



Result: The Maximum Displacement of the component is about 1.0559e-10 mm. This Displacement is below the limit of 3.0e-11 mm so it is acceptable.

Result: The Maximum Displacement of the component at Y is about 9.0e-11 mm. This Displacement is below the limit of 3.0e-10 mm so it is acceptable.

Material: BRASS



Result: The Maximum VonMises Stress applied on the component is less than 2.460e-04 kg/(mm sec^2). This stress is below the limit of 3.0e-02 kg/(mm sec^2)so it is acceptable.
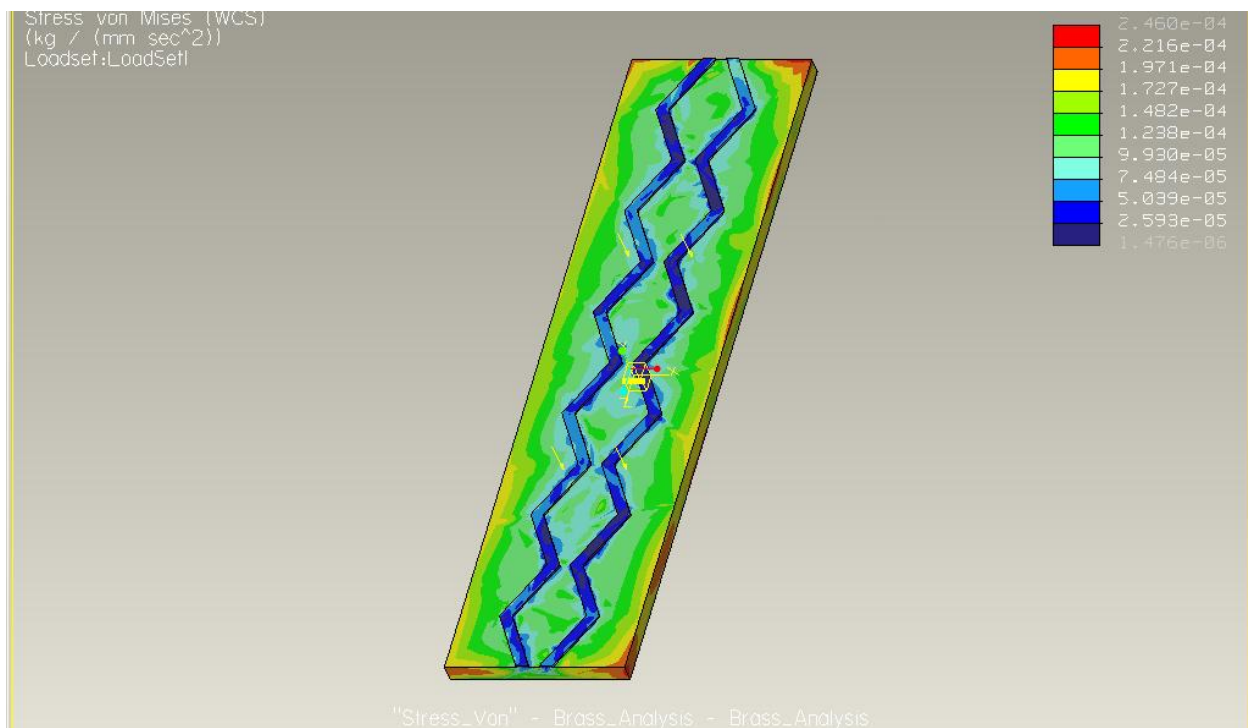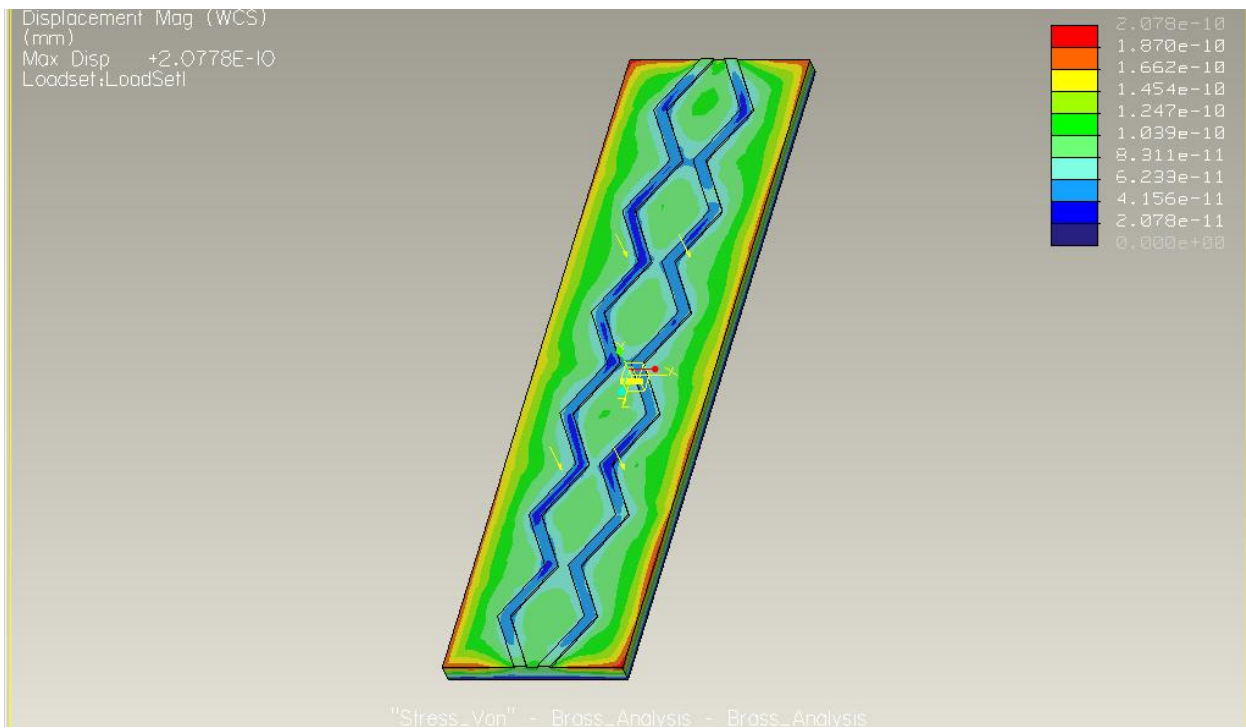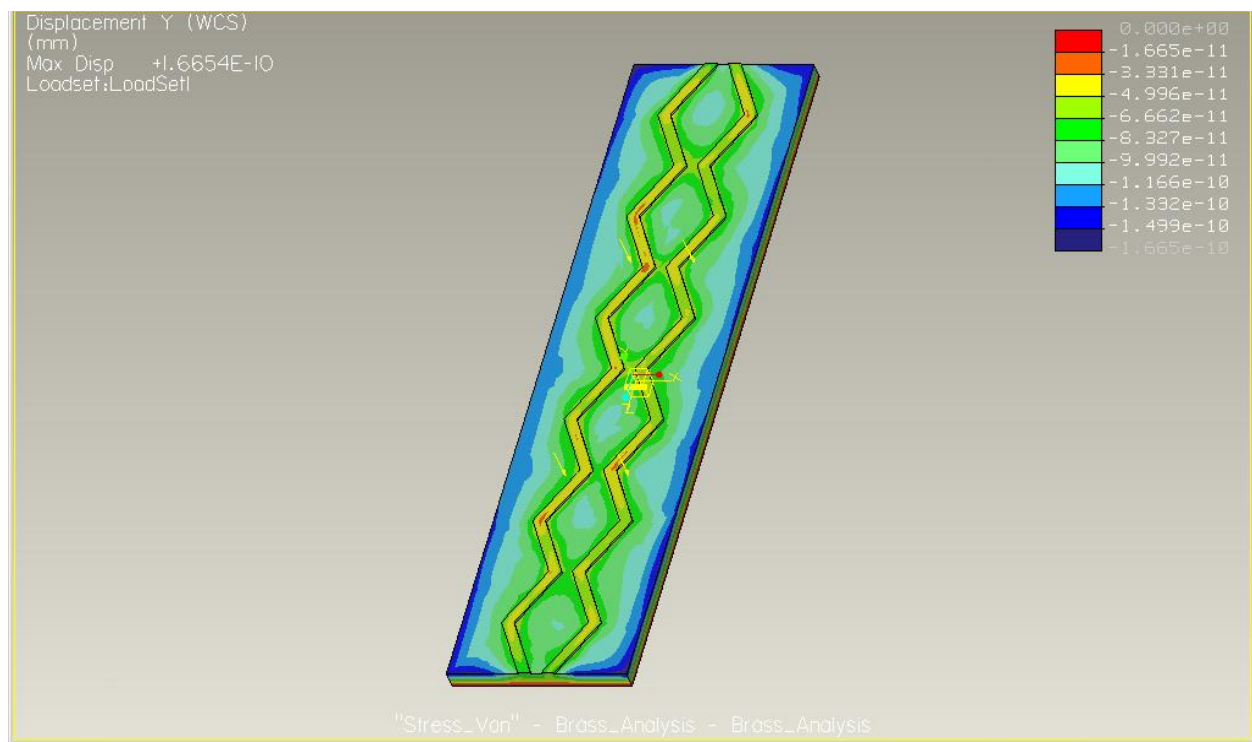
Result: The Maximum Displacement of the component is about 2.0778e-10 mm. This Displacement is below the limit of 3.0e-10 mm so it is acceptable.



Result: The Maximum Displacement of the component at Y is about 1.6654e-10 mm. This Displacement is below the limit of 3.0e-10 mm so it is acceptable.

Material: ALUMINIUM



Result: The Maximum VonMises Stress applied on the component is less than 2.452e-04 kg/(mm sec^2). This stress is below the limit of 3.0e-02 kg/(mm sec^2) so it is acceptable.


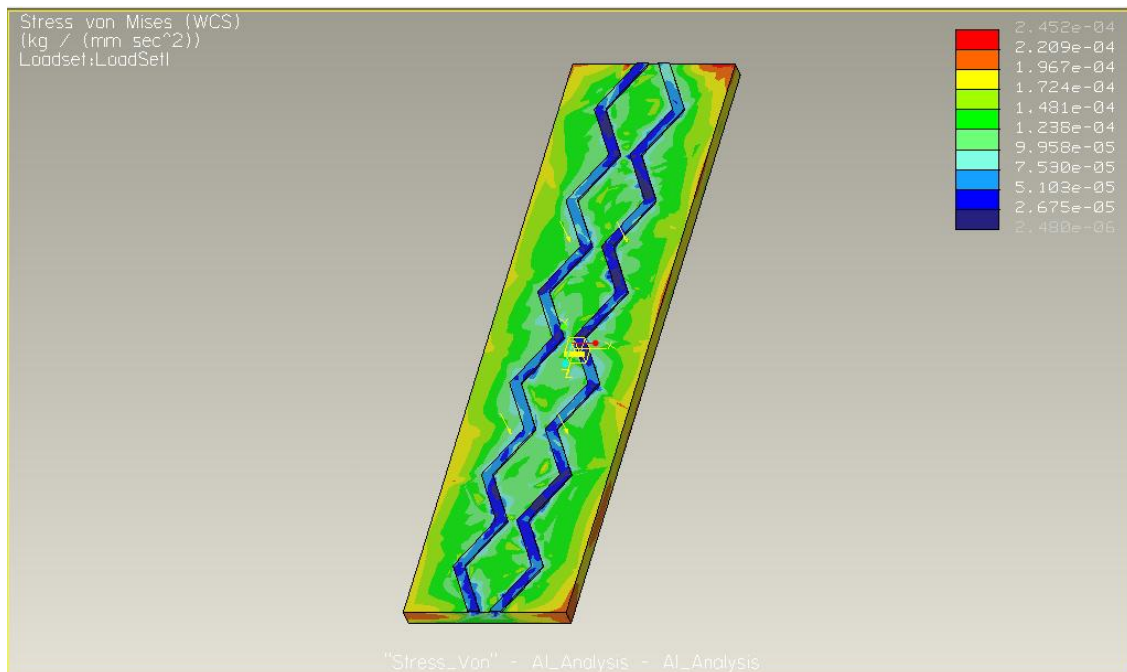
Result: The Maximum Displacement of the component is about 2.9566e-10 mm. This Displacement is below the limit of 3.0e-10 mm so it is acceptable.
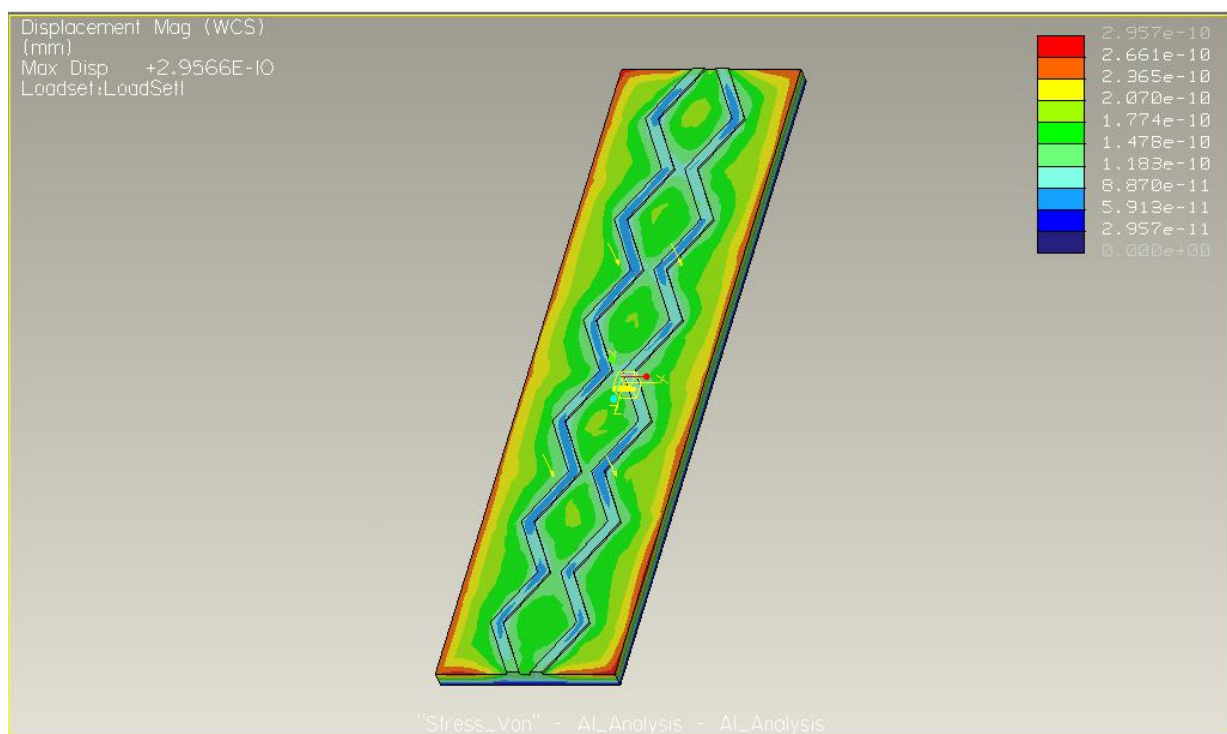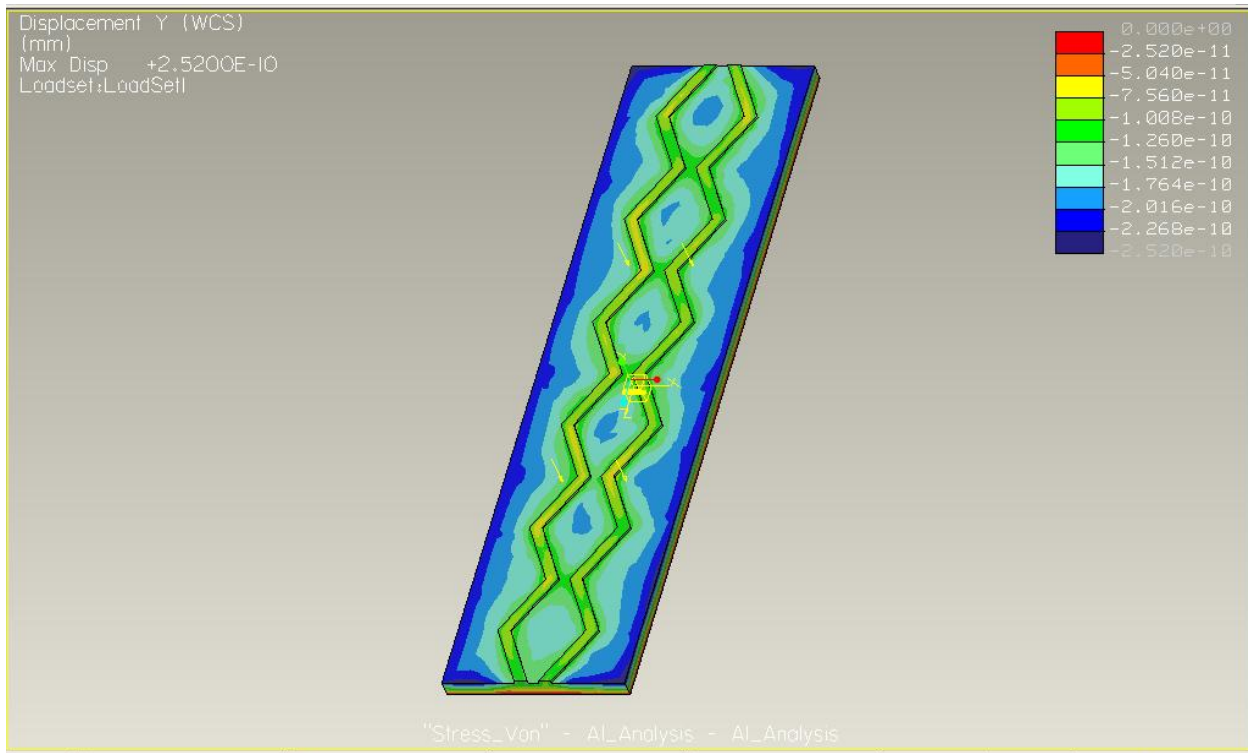
Result: The Maximum Displacement of the component at Y is about 2.5200e-10 mm. This Displacement is below the limit of 3.0e-10 mm so it is acceptable.

Material: TUNGESTEN



Result: The Maximum VonMises Stress applied on the component is less than 2.454e-04 kg/(mm sec^2). This stress is below the limit of 3.0e-02 kg/(mm sec^2) so it is acceptable.

Result: The Maximum Displacement of the component is about 6.6386e-11 mm. This Displacement is below the limit of 3.0e-10 mm so it is acceptable.



Result: The Maximum Displacement of the component at Y is about 5.5941e-11 mm. This Displacement is below the limit of 3.0e-10 mm so it is acceptable.
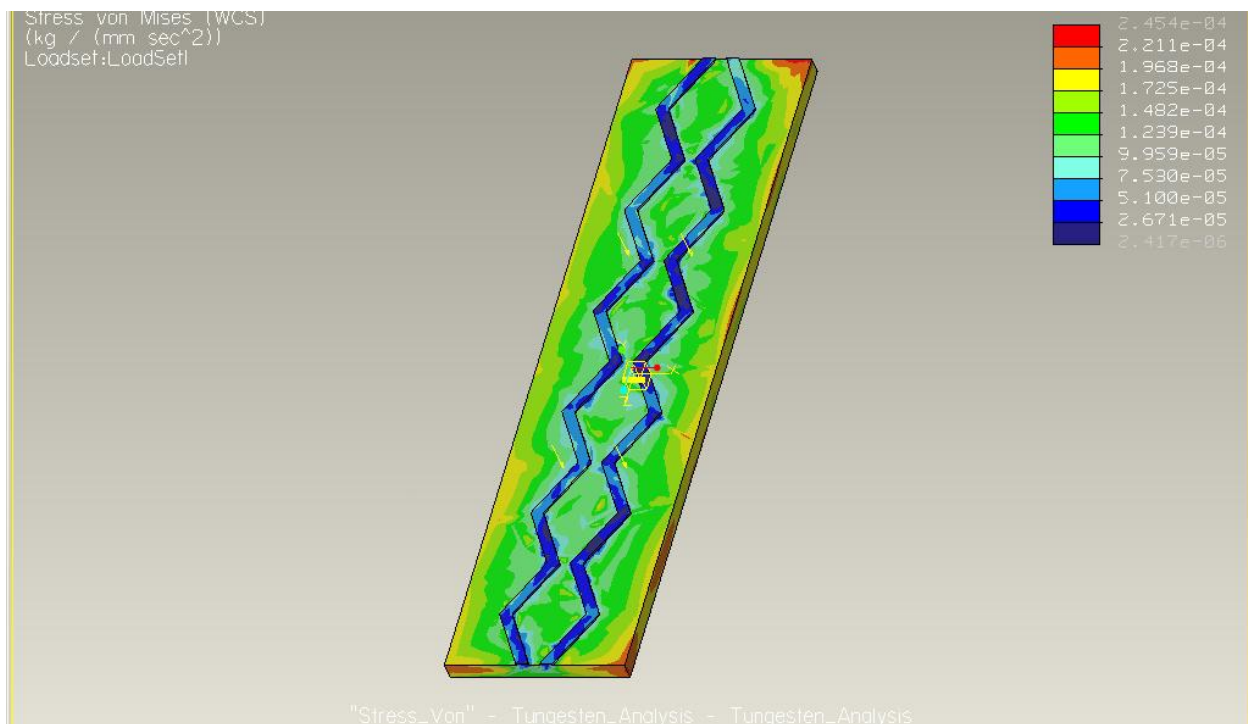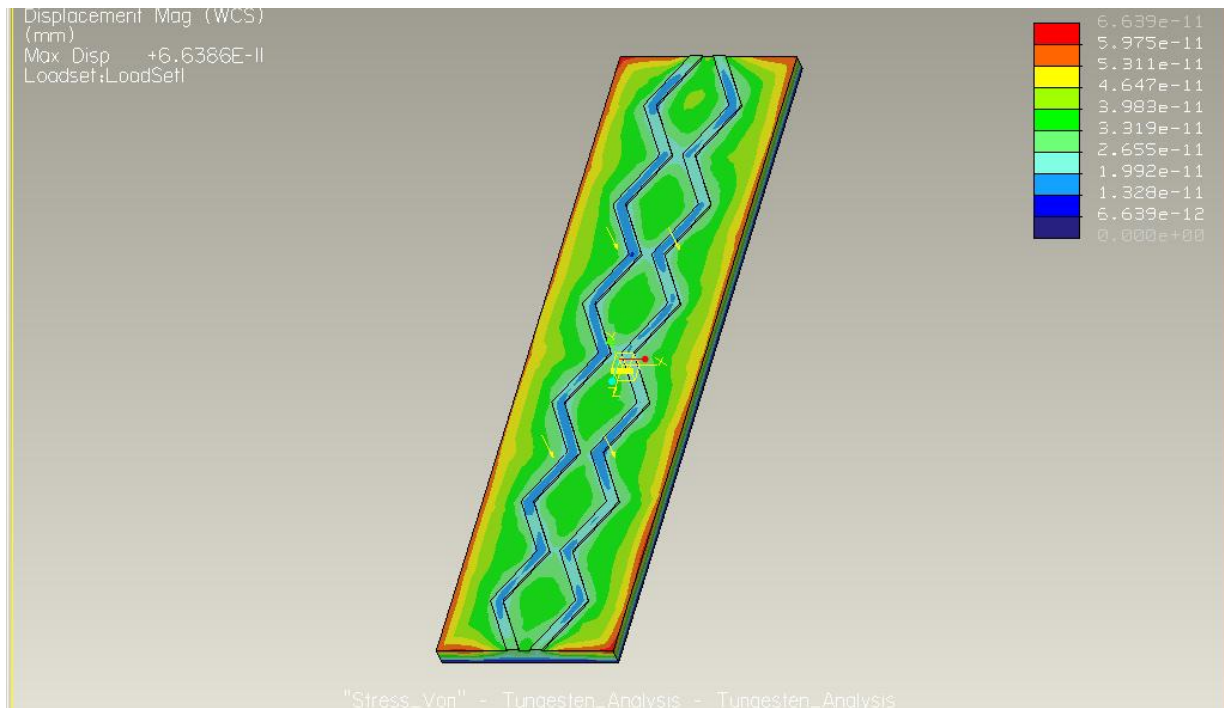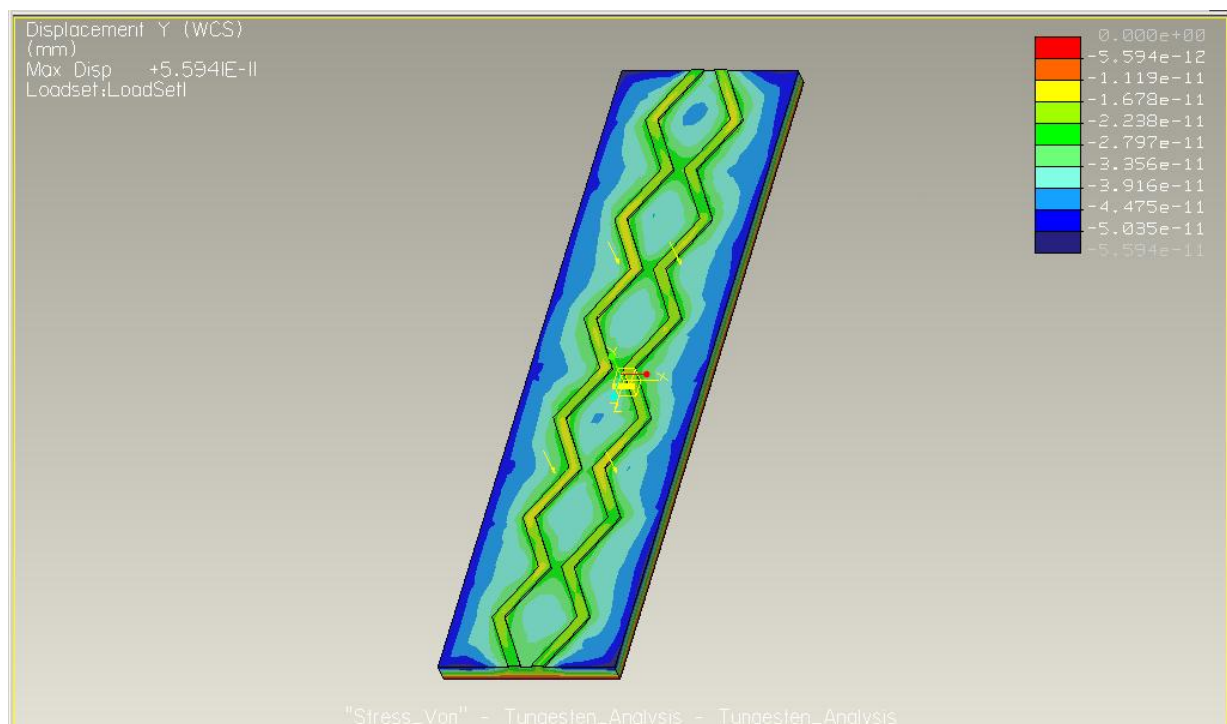
**SUMMARY**

| Sr. | Material | Max VonMises Stress [3.0e-02 kg/(mm sec^2)] | Max Displacement (Magnitude) 2.10e-10 mm | Max Perpendicular (Y Axis) Displacement 2.0e-10 mm | Result |
|---|---|---|---|---|---|
| 01 | Conventional Plate | 2.337e-04 | 1.5130e-10 | 1.2199e-10 | Acceptable but not Advisable |
| 02 | Copper | 2.460e-04 | 1.6403e-10 | 1.3148e-10 | Acceptable |
| 03 | Steel | 2.449e-04 | 9.8900e-11 | 8.7198e-11 | Acceptable |
| 04 | Stainless Steel | 2.452e-04 | 1.0559e-10 | 9.0000e-11 | Acceptable |
| 05 | Brass | 2.460e-04 | 2.0778e-10 | 1.6654e-10 | Acceptable but not Advisable |
| 06 | Aluminium | 2.452e-04 | 2.9566e-10 | 2.5200e-10 | Not Acceptable |
| 07 | Tungesten | 2.454e-04 | 6.6386e-11 | 5.5941e-11 | Acceptable |

**CONCLUSION**

From above Summary it is concluded that the Zig-Zag Embossed Bed Plate made from Copper, Steel, Stainless Steel & Tungsten Plates are acceptable while Aluminium Plate is not acceptable. The remaining Brass Plate is below the safe limit but the difference is less so it is not advisable to use this plate.

The conventional plate made is also having safe region but it is not advisable because the reason & limitations shown above.

Now we have to select the best materials from the four materials which are Copper, Steel, Stainless Steel & Tungsten. The best among these four is Tungsten but it is very costly so it is not advisable to use it.

Comparison between advisable materials:

| Material | Max VonMises Stress | Max Displacement (Magnitude) | Max Perpendicular (Y Axis) Displacement |
|---|---|---|---|
| Copper | 2.460e-04 | 1.6403e-10 | 1.3148e-10 |
| Steel | 2.449e-04 | 9.8900e-11 | 8.7198e-11 |
| Stainless Steel | 2.452e-04 | 1.0559e-10 | 9.0000e-11 |

Here we can observe that the Max VonMises Stress of Steel is lower compare to others. But the Max Displacement at Y of Steel is more than Stainless Steel and the Stress & Max Displacement (Magnitude) of Steel are better than Stainless Steel.

So, finally the comparison between the Stainless Steel & Steel is done. Now we move towards the cost comparison & the cost of Steel is less than Stainless Steel so, final selection is the <u>Steel</u> as the Bed Plate material.

So, after doing whole analysis the conclusion is that the Steel is the best material for the Bed Plate for the Laser Cutting Machine.

## REFERENCES

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