Custom Testing Machine for Weak Layers specimens

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Introduction

A custom designed machine is proposed for specimens composed of weak layers of material testing, capable of performing shear, compression, or mixed tests. The device has 2 degrees-of-freedom, implementing controlled linear movement in both vertical and horizontal directions. The velocity ranges from 30 mm/s down to 0.001 mm/s, and the maximum force capacity is 500 N. Additionally, the machine can operate at a temperature of -10°C and relative humidity of ≤95%, with low deformation (<5µm).

For precise control, a mechanical system that allows rotation up to ±5° is included, compensating for possible misalignments of the specimens thus preventing unwanted forces or torque on the specimen.

Project methodology

The structure was designed in a bench type press, ensuring good access to the sample, shown in Figure 1. The design of the structural parts was carried out through interactive processes due to the complexity of the machine, The design and simulations were carried out using Solidworks 2022. An electromechanical system was chosen for the actuation due to its good control capabilities and high accuracy.

In the structure developed, the working conditions required the use of corrosion resistant materials; aluminium 7075 was used for larger parts, as it has high mechanical strength and relatively low density, while AISI 316 stainless steel was used for smaller parts.

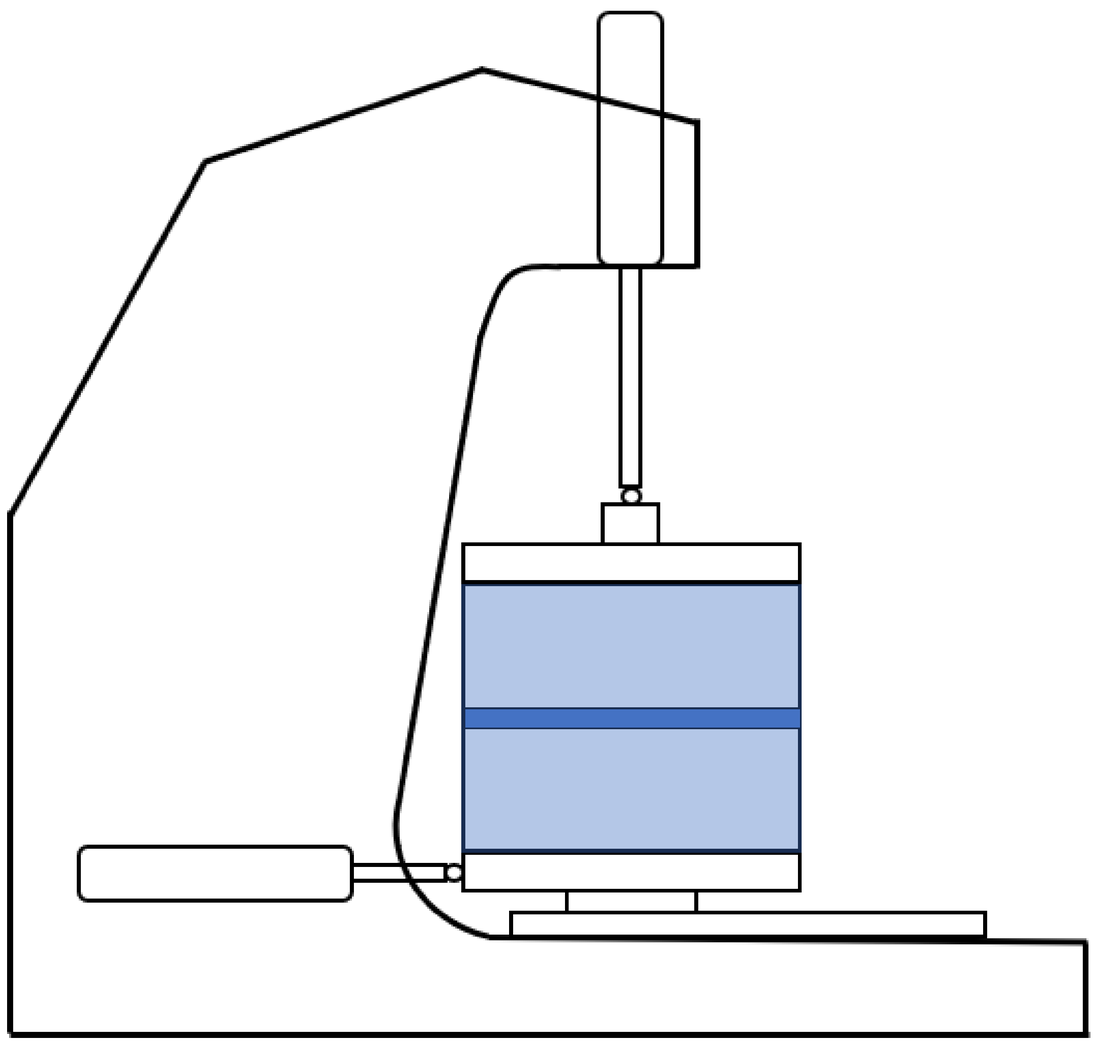

Figure 1 – Machine model

Experimental results

A finite element simulation was carried out to analyse the deformation, with the compression and shear combined test being the most critical. Two 500 N forces were applied to the vertical actuator support, respectively, resulting in a total deformation of the structure of 4.4 µm, shown in Figure 2.

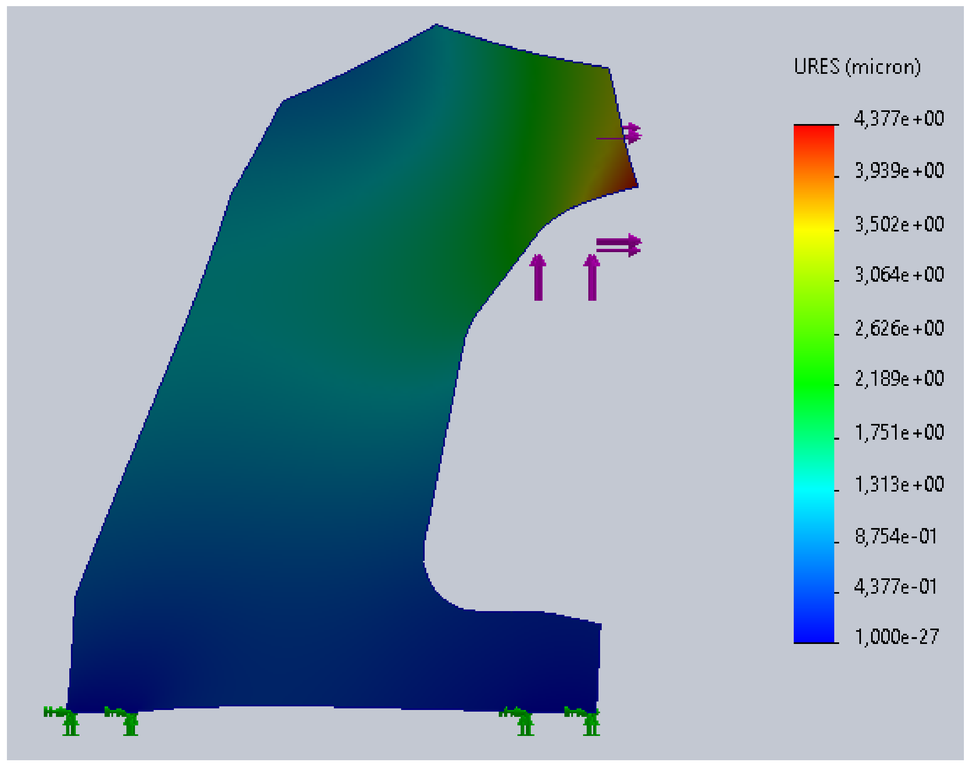

Figure 2 – Result of deformation analysis by finite element simulation.

Selected automation elements

The control system has been designed, using a computer, connected via TPC/IP Ethenet to an EtherCAT control system and data acquisition system. The selected control architecture are shown in Figure 3.

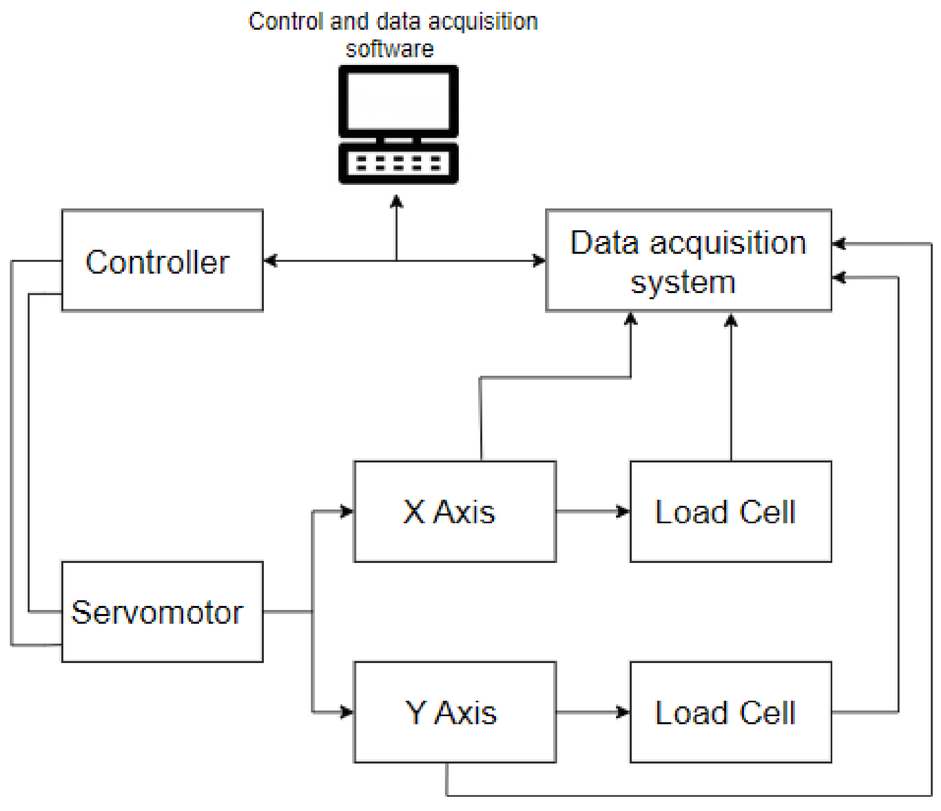

Figure 3 – Electronics and control system diagram

Conclusions

In conclusion, it was found that the structure was able to withstand the 5 µm of deformation required, although it was not possible to show more results of the system in operation as there are elements in delivery. Future work will involve assembling the machine and testing it.