7.2 Test case 2: Linear elastic range

Aim: The matrix material follows the Von Mises surface when the material has not any damage, therefore during a load until the yield point the the GTN and VM material have the same behaviour. In this test is evaluated the variations on the parameters of the elastic region.

Expected result: The behaviour must be exactly the same until the yield point, in order to show it, it is represented the solution of the stress vs the S11 strain.

In this test was evaluated the change of the yield point and the Young's modulus, in each case was evaluate 5 cases.

210000	0.33	50	50	100	1.5	1	1.5	0.004	0.1	0.3	0.2025	0.1	0.25	0.1
210000	0.33	100	50	100	1.5	1	1.5	0.004	0.1	0.3	0.2025	0.1	0.25	0.1
210000	0.33	150	50	100	1.5	1	1.5	0.004	0.1	0.3	0.2025	0.1	0.25	0.1
210000	0.33	200	50	100	1.5	1	1.5	0.004	0.1	0.3	0.2025	0.1	0.25	0.1
210000	0.33	220	50	100	1.5	1	1.5	0.004	0.1	0.3	0.2025	0.1	0.25	0.1

Figure 11: Parameters used in test elasticity range-change yield point

150000	0.33	200	50	100	1.5	1	1.5	0.004	0.1	0.3	0.2025	0.1	0.25	0.1
175000	0.33	200	50	100	1.5	1	1.5	0.004	0.1	0.3	0.2025	0.1	0.25	0.1
200000	0.33	200	50	100	1.5	1	1.5	0.004	0.1	0.3	0.2025	0.1	0.25	0.1
250000	0.33	200	50	100	1.5	1	1.5	0.004	0.1	0.3	0.2025	0.1	0.25	0.1
300000	0.33	200	50	100	1.5	1	1.5	0.004	0.1	0.3	0.2025	0.1	0.25	0.1

Figure 12: Parameters used in test elasticity range-change Young's modulus

Command used to run the program: For this test you find in the main folder the following files

```
test_elast_be1.for
test_elast$_be2.for
```

Additionally in the folder 4_Test_lin_elas0/ you find:

Parameters of the test

```
dat_LE_01.csv
dat_LE_02.csv
```

Files to generate plot the results

```
$ python3 Ana_test_lin_elas1.py
$ python3 Ana_test_lin_elas2.py
```

To run the test, compile the files in the main folder and run the generated executable file. it takes around 30-40 minutes to generate the results

```
$ gfortran tensor_ope_module.for material_law_GTN.for test_elast_be.for  -llapack
$ ./a.out

$ gfortran tensor_ope_module.for material_law_GTN.for test_elast_be2.for  -llapack
$ ./a.out
```

The csv files with the results are generated in the folder 4_Test_lin_elas0/. Now, change to that the folder and run the python files

```
$ cd 4_Test_lin_elas0/
$ python3 Ana_test_lin_elas.py
$ python3 Ana_test_lin_elas1.py
```

The figure with the results is generated in the folder respectively in the folders 1_Fig_3D and 2_Fig_PS.

Obtained result: For a constant Young's module there is little increase in the yield point compared to the von Mises reference data, figure 13. This should be due to the initial void volume fraction of 0.005 include included as parameter of the test. For the same yield point and different Young's module the response is the same, figure 14.

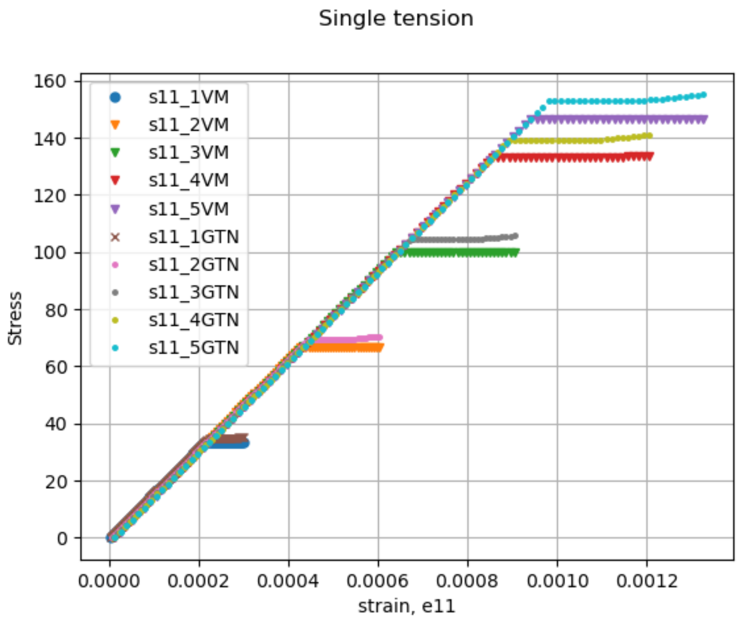

Figure 13: Comparation GTN and VM material laws in the elastic region changing the yield point

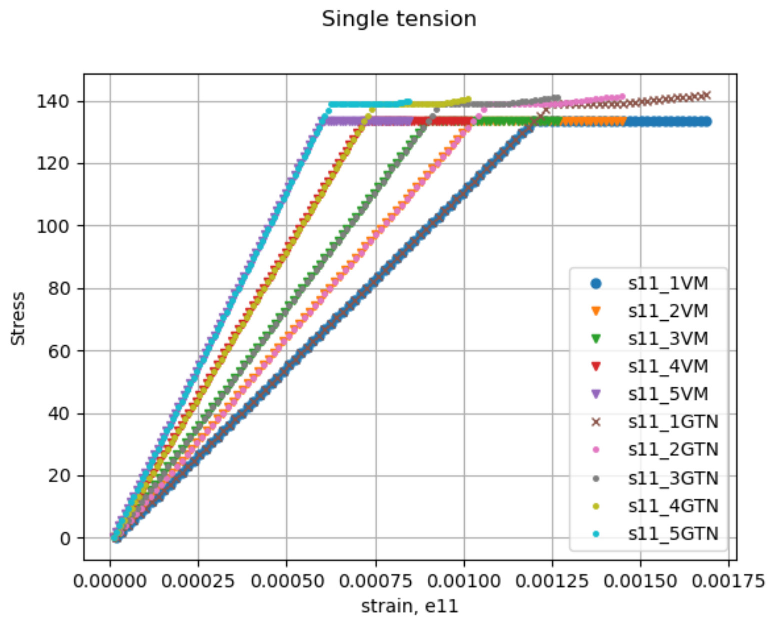

Figure 14: Comparation GTN and VM material laws in the elastic region changing the Young's modulus

7.3 Test case 3:material point Isochoric tension

Aim: In this test is evaluated the performance of algorithm at the material point level, especially the plastic return, when a controlled $\mathcal{E}_{11}$, $\mathcal{E}_{22}$, $\mathcal{E}_{33}$, strain is applied to the element.

Expected result: Find that the ISV variable, void volume fraction, microscopic plastic strain increases its values through the time (strain). Also observe that the code, especially in the plastic zone converges

Command used to run the program:For this test you find in the main folder the following files. The parameters used in this test are the kind of analysis performed 3D or plain stress, the parameter that change this option is set in each of the following files. File to run the test, these files are based on the notes of the course Plasticity WS2020 TUBAF

```
test_isochoric_tension3D.for
test_isochoric_tensionPS.for
```

In the folder 5_Isochoric_test/ you find the files to plot the results

```
fi_test_MatLaw3D.py
fi_test_MatLawPS.py
```

To run the test, compile the files in the main folder and run the generated executable file. It takes around 10-15 minutes to generate the results. The parameters for this test are the standard parameters as are indicated in the section and are set in the file to run the test.

```
$ gfortran tensor_ope_module.for material_law_GTN.for test_isochoric_tension3D.for -llapack
$ ./a.out
$ gfortran tensor_ope_module.for material_law_GTN.for test_isochoric_tensionPS.for -llapack
$ ./a.out
```

The csv files with the results are generated in the folder 5_Isochoric_test/. Now, change to that the folder and run the python files