

CONSIDERATIONS REGARDING THE STRUCTURAL RESPONSE OF A 10000X500X100MM PILE DURING PILE DRIVING WITH A 450KG RAM, FALLING FROM 1M HEIGHT

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Abstract: Piles are used when the building soil don't have enough strength to support the structure. One of the piling methods is to drive the pile. In fact, a vertical pile is hit with a ram. This method is a very good one, because the soil around the pile is compressed and the structure bed is strengthened that way. The negative aspect of this method is the pile is solicited in other ways than it was design. In this paper are presented the results of a dynamic FEM analysis for a 10000x500x100mm pile when it is hit by a 450kg ram, falling from 1m height.

Keywords: FEM, Structural analysis, pile driving

Piles are used when the building soil don't have enough strength to support the structure.

One of the piling methods is to drive the pile. In fact, a vertical pile is hit with a ram. This method is a very good one, because the soil around the pile is compressed and the structure bed is strengthened that way. The negative aspect of this method is the pile is solicited in other ways than it was design.

A standard operation of pile driving is presented in below picture.



Figure 1 A standard pile driving operations
(www.vulcanhammer.info)

For piling operations, piles are structural checked for this kind of operation.

This paperwork presents an analysis of the structural response for a 10000x500x100mm pile when is driven with a 450kg ram who falls from 1 m height. For the analysis was used Ansys 12.1 software.

The pile and the ram were modeled like in below figure:

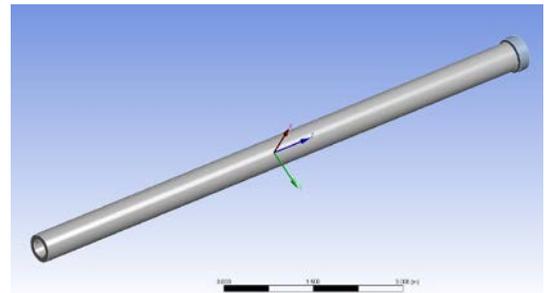


Figure 2 The model of the pile and ram, at the impact moment

The mesh consists in 10260 nodes and 5103 elements:

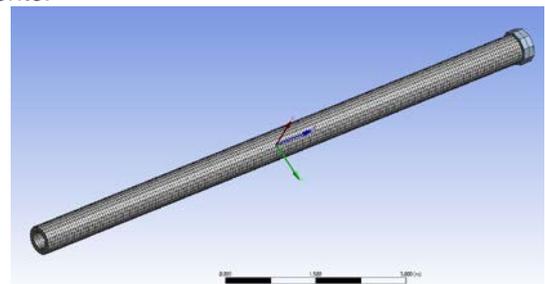


Figure 3 The mesh structure

The pile was considered to be fixed at the base, and the ram hits the top with 4.429 m/s impact speed. This speed corresponds with the impact speed after 1 m fall.

For studying the structural response we considered the von Mises tensions.

The study was carried out as a dynamic one for one second, in 101 steps:

Table 1: Analysis steps

Step	Time	Step	Time
1	0.00	21	0.20
2	0.01	22	0.21
3	0.02	23	0.22
4	0.03	24	0.23
5	0.04	25	0.24
6	0.05	26	0.25
7	0.06	27	0.26
8	0.07	28	0.27
9	0.08	29	0.28
10	0.09	30	0.29
11	0.10	31	0.30
12	0.11	32	0.31
13	0.12	33	0.32
14	0.13	34	0.33
15	0.14	35	0.34
16	0.15	36	0.35
17	0.16	37	0.36
18	0.17	38	0.37
19	0.18	39	0.38
20	0.19	40	0.39

41	0.40	61	0.60
42	0.41	62	0.61
43	0.42	63	0.62
44	0.43	64	0.63
45	0.44	65	0.64
46	0.45	66	0.65
47	0.46	67	0.66
48	0.47	68	0.67
49	0.48	69	0.68
50	0.49	70	0.69
51	0.50	71	0.70
52	0.51	72	0.71
53	0.52	73	0.72
54	0.53	74	0.73

55	0.54	75	0.74
56	0.55	76	0.75
57	0.56	77	0.76
58	0.57	78	0.77
59	0.58	79	0.78
60	0.59	80	0.79

Step	Time	Step	Time
81	0.80	91	0.90
82	0.81	92	0.91
83	0.82	93	0.92
84	0.83	94	0.93
85	0.84	95	0.94
86	0.85	96	0.95
87	0.86	97	0.96
88	0.87	98	0.97
89	0.88	99	0.98
90	0.89	100	0.99
		101	1.00

The minimum value of the von Mises stress for each step is presented below:

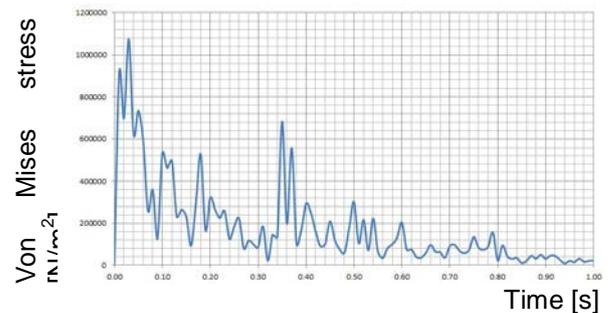


Figure 4 Minimum von Mises stress value variation

The maximum value of the von Mises stress for each step is presented below:

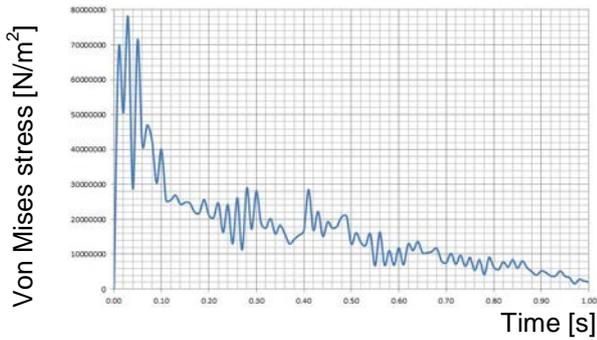


Figure 5 Maximum von Mises stress valuevariation

Repartition diagram of the equivalent stress after the impact are presented as follows:

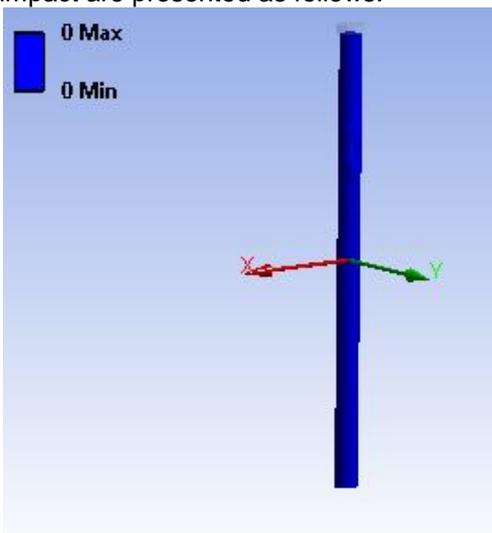


Figure 6 Von Mises stress diagram for step 1

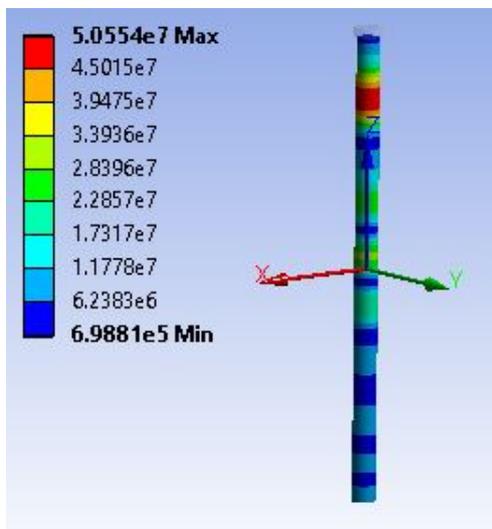


Figure 7 Von Mises stress diagram for step 3

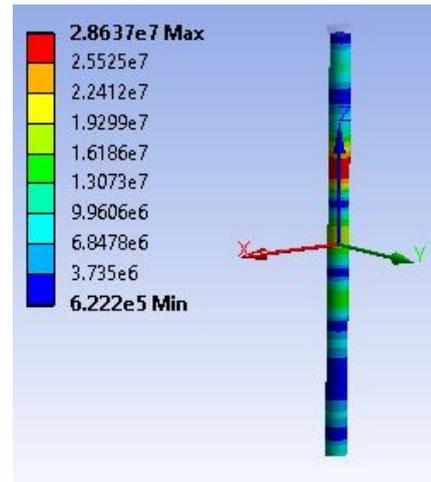


Figure 8 Von Mises stress diagram for step 5
6

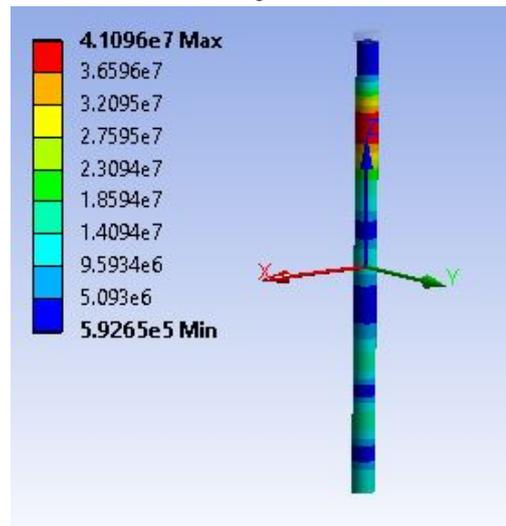


Figure 9 Von Mises stress diagram for step 7

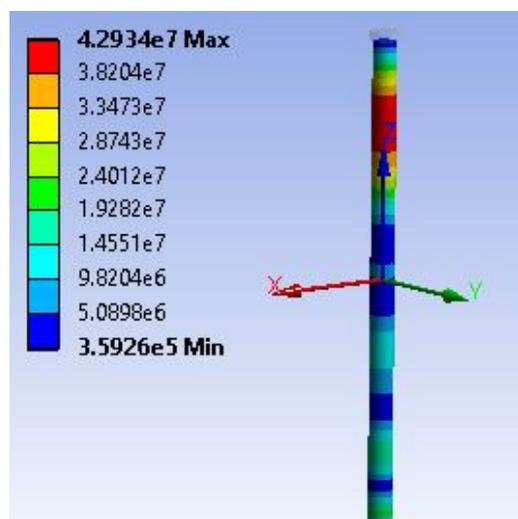


Figure 10 Von Mises stress diagram for step 9
9

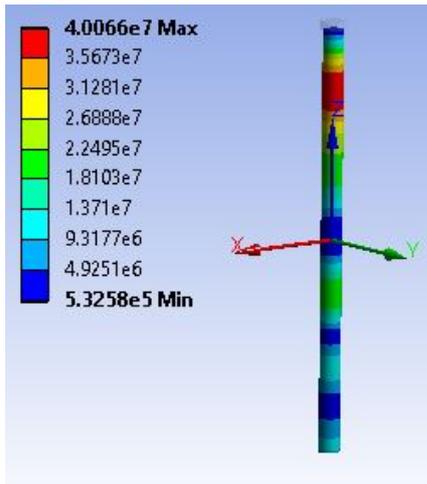


Figure 11 Von Mises stress diagram for step 11

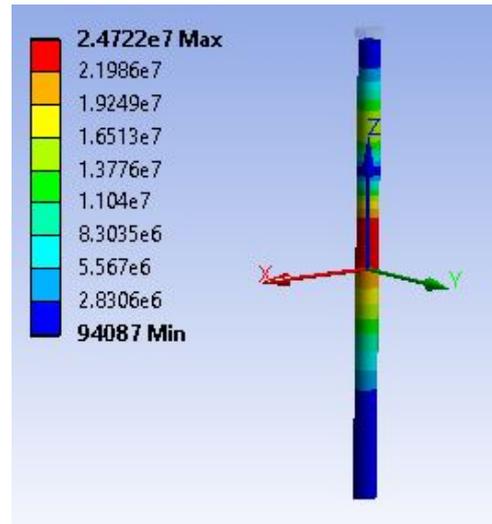


Figure 14 Von Mises stress diagram for step 17

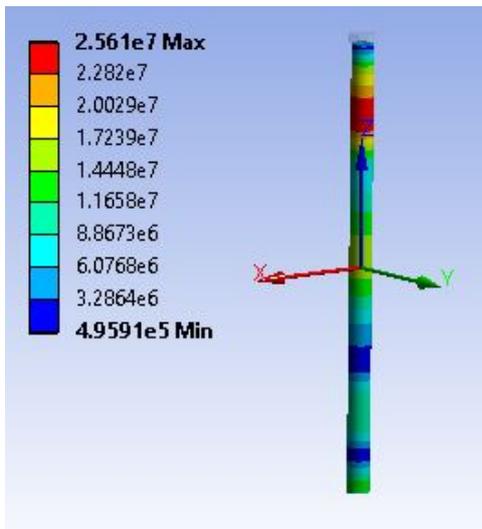


Figure 12 Von Mises stress diagram for step 13

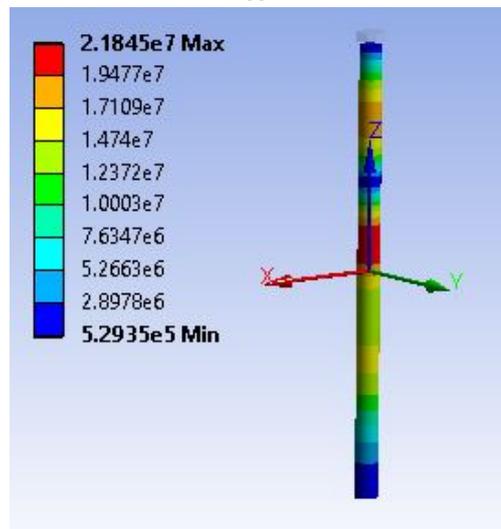


Figure 15 Von Mises stress diagram for step 19

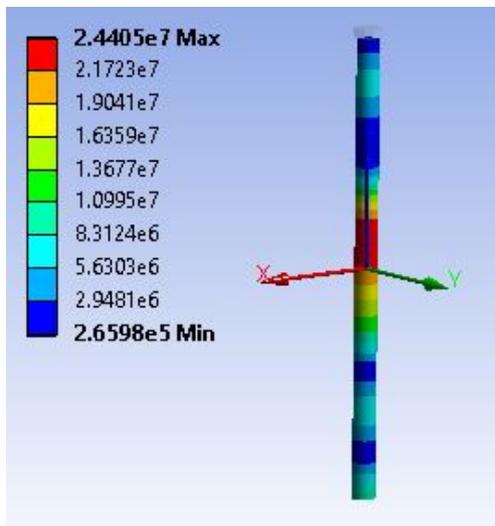


Figure 13 Von Mises stress diagram for step 15

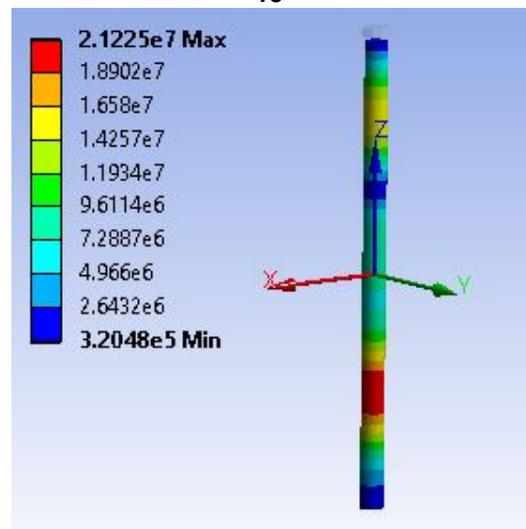


Figure 16 Von Mises stress diagram for step 21

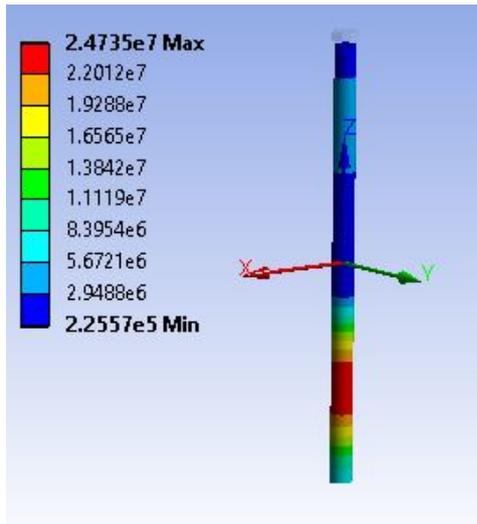


Figure 17 Von Mises stress diagram for step 23

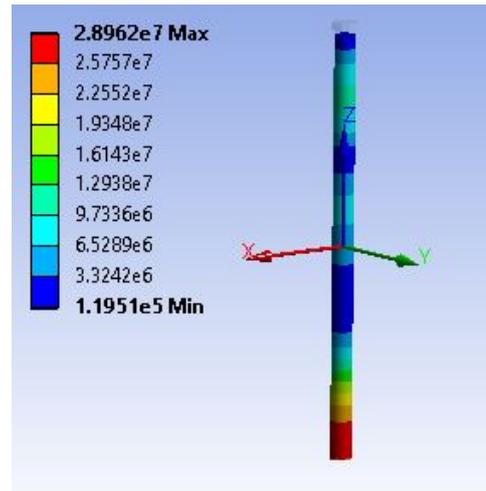


Figure 20 Von Mises stress diagram for step 29

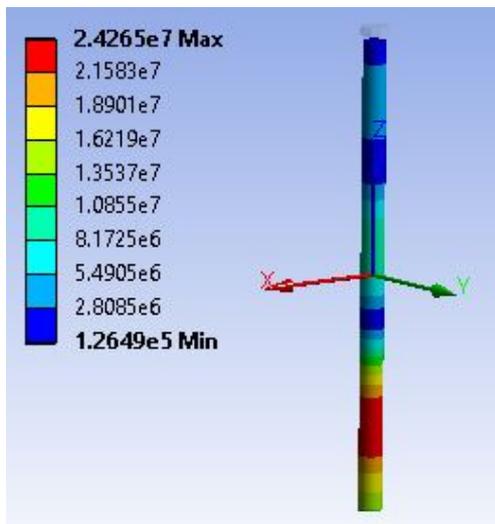


Figure 18 Von Mises stress diagram for step 25

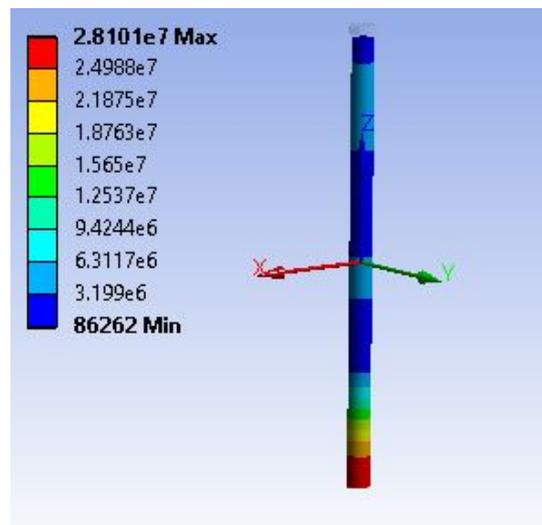


Figure 21 Von Mises stress diagram for step 31

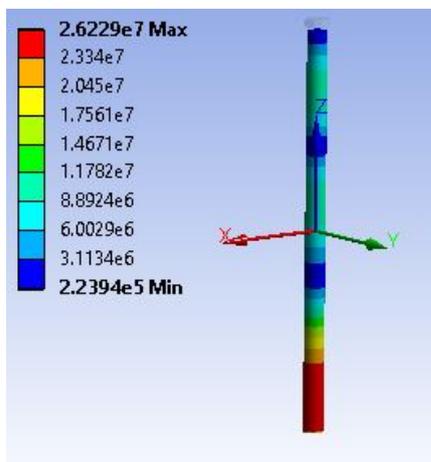


Figure 19 Von Mises stress diagram for step 27

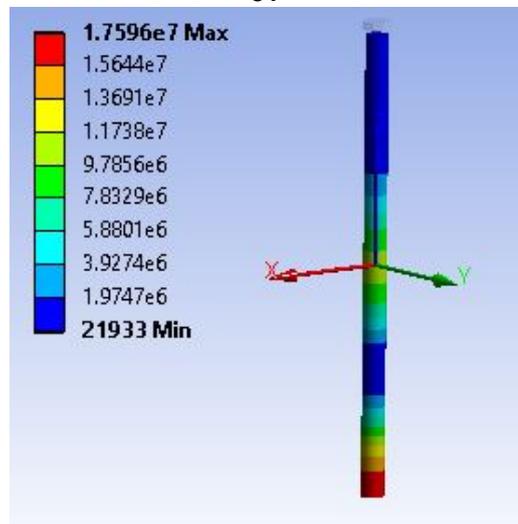


Figure 22 Von Mises stress diagram for step 33

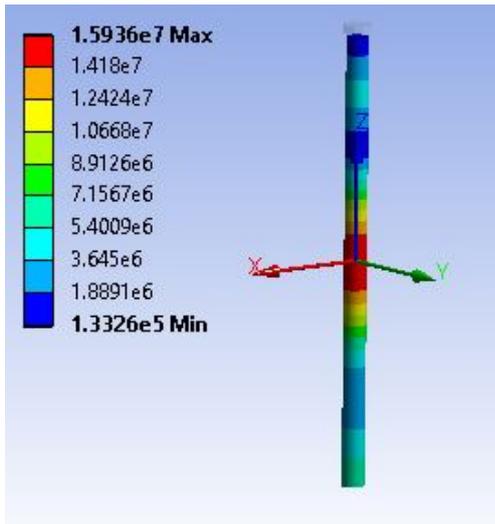


Figure 23 Von Mises stress diagram for step 35

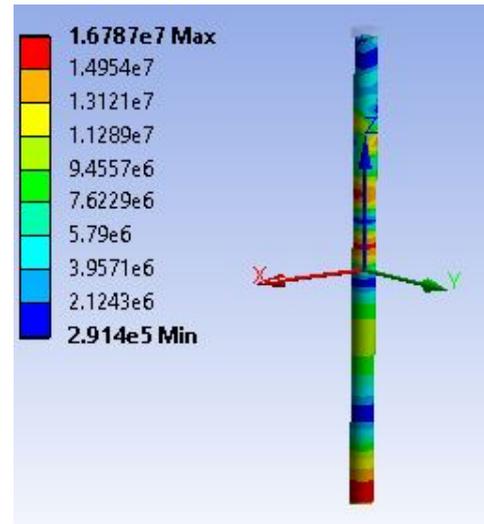


Figure 26 Von Mises stress diagram for step 41

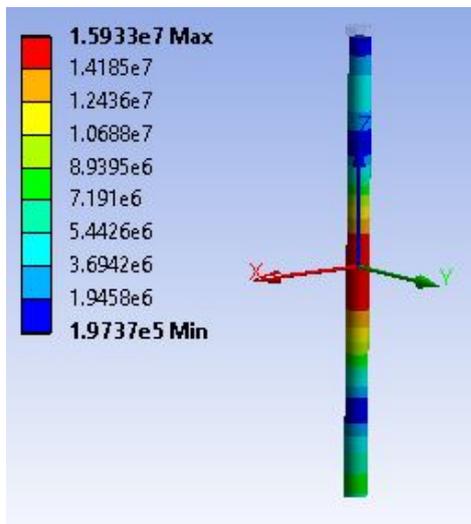


Figure 24 Von Mises stress diagram for step 37

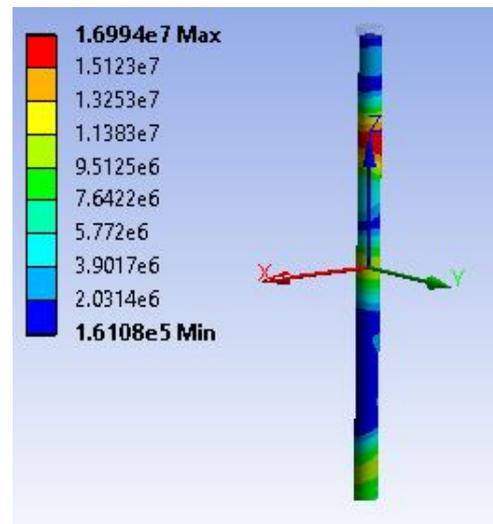


Figure 27 Von Mises stress diagram for step 43

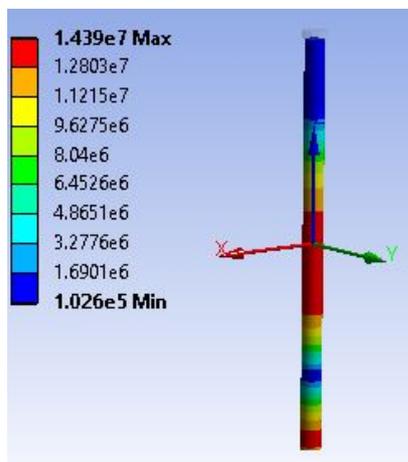


Figure 25 Von Mises stress diagram for step 39

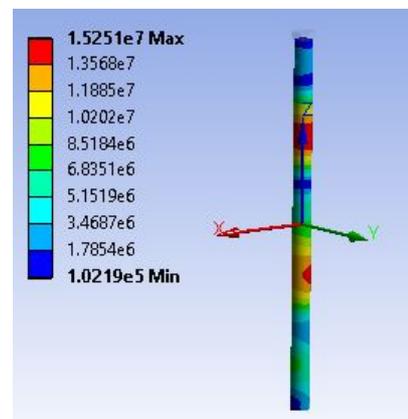


Figure 28 Von Mises stress diagram for step 45

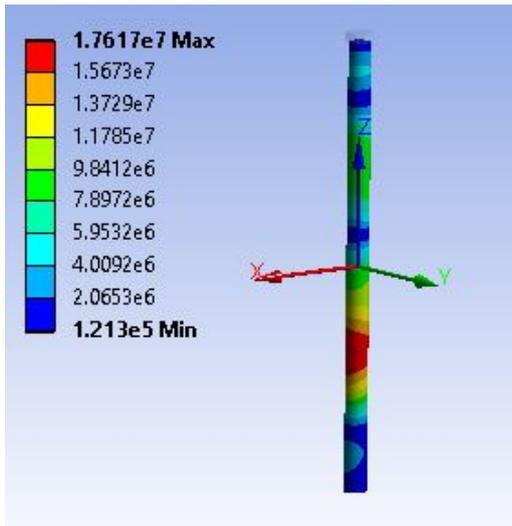


Figure 29 Von Mises stress diagram for step 47

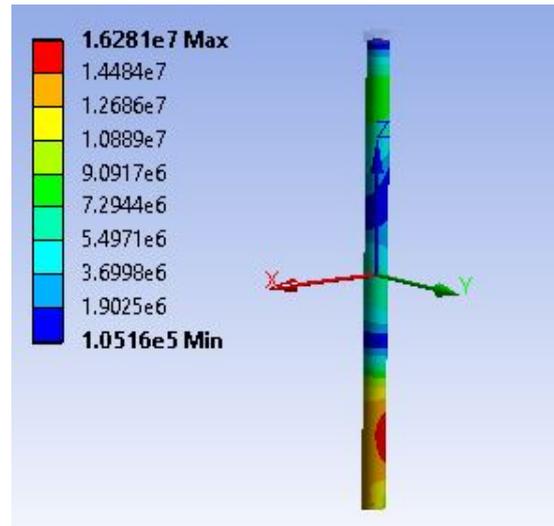


Figure 32 Von Mises stress diagram for step 53

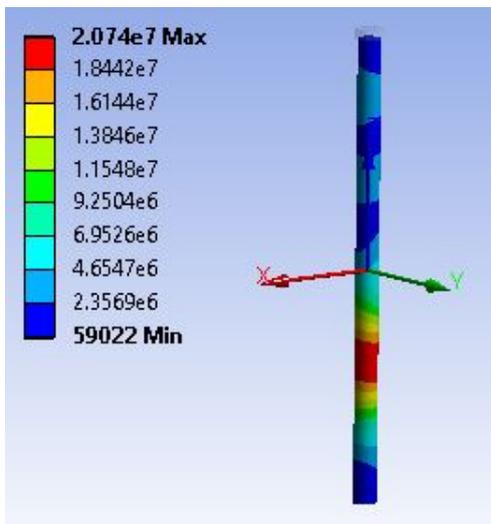


Figure 30 Von Mises stress diagram for step 49

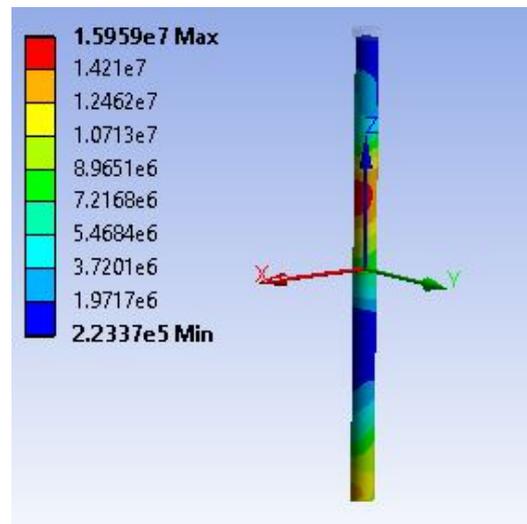


Figure 33 Von Mises stress diagram for step 55

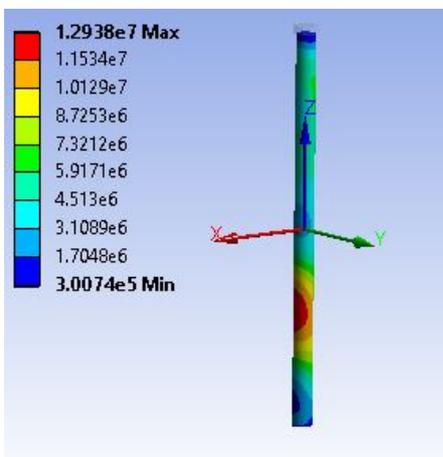


Figure 31 Von Mises stress diagram for step 51

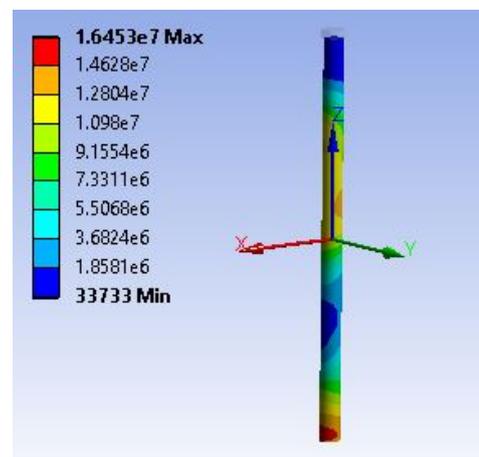


Figure 34 Von Mises stress diagram for step 57

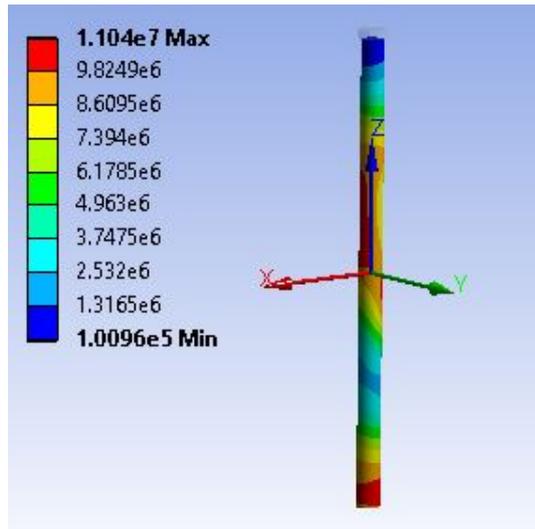


Figure 35 Von Mises stress diagram for step 59

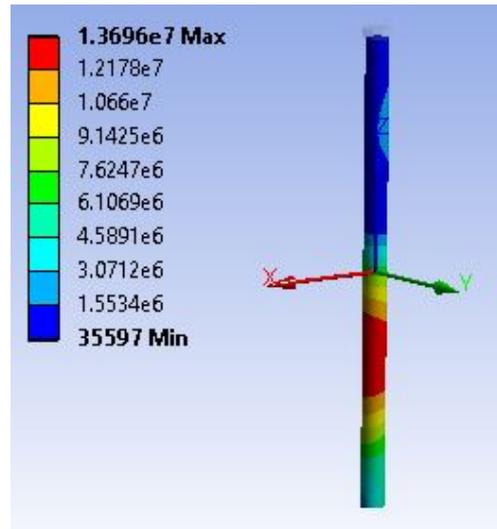


Figure 38 Von Mises stress diagram for step 65

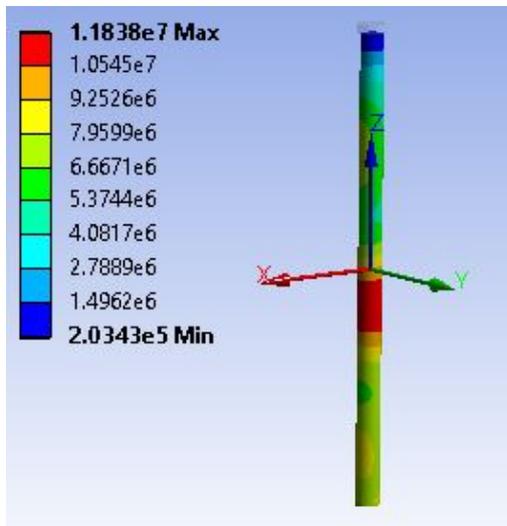


Figure 36 Von Mises stress diagram for step 61

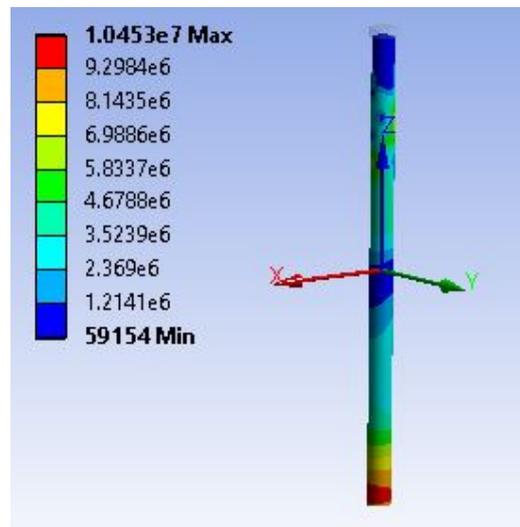


Figure 39 Von Mises stress diagram for step 67

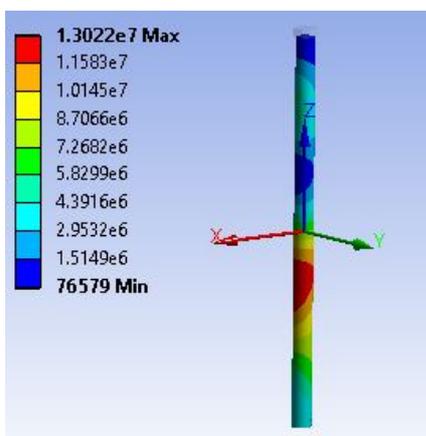


Figure 37 Von Mises stress diagram for step 63

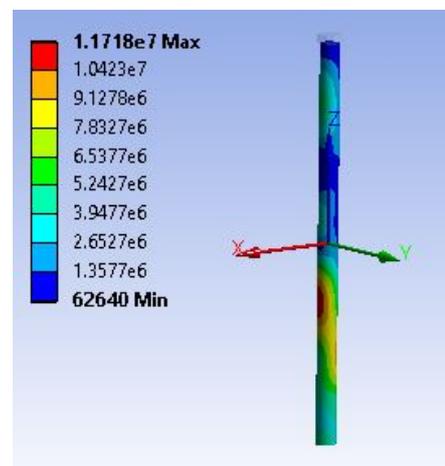


Figure 40 Von Mises stress diagram for step 69

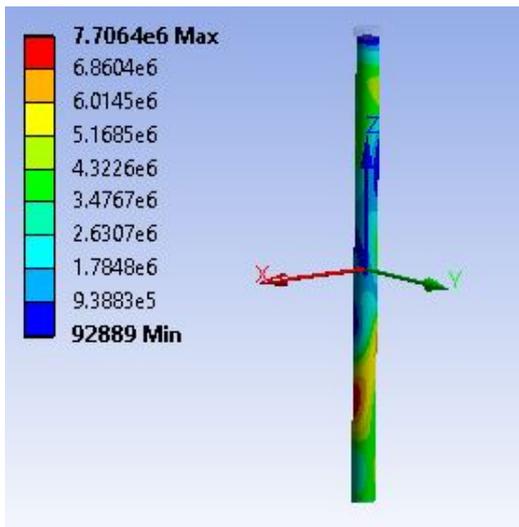


Figure 41 Von Mises stress diagram for step 71

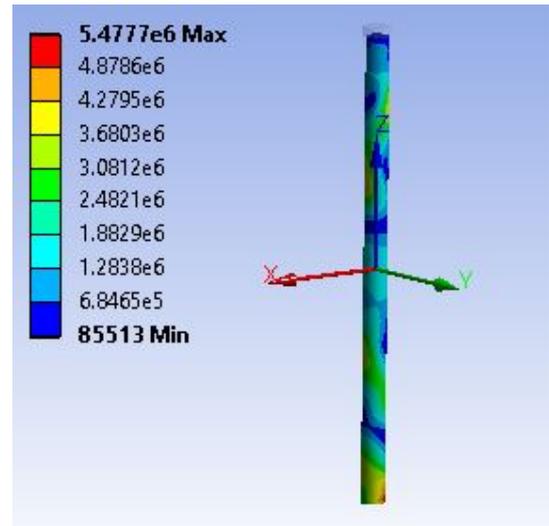


Figure 44 Von Mises stress diagram for step 77

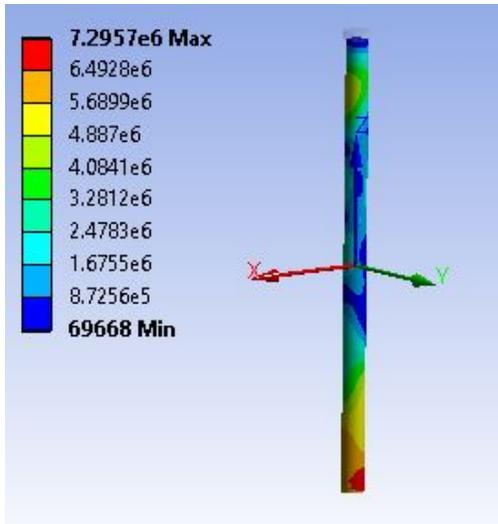


Figure 42 Von Mises stress diagram for step 73

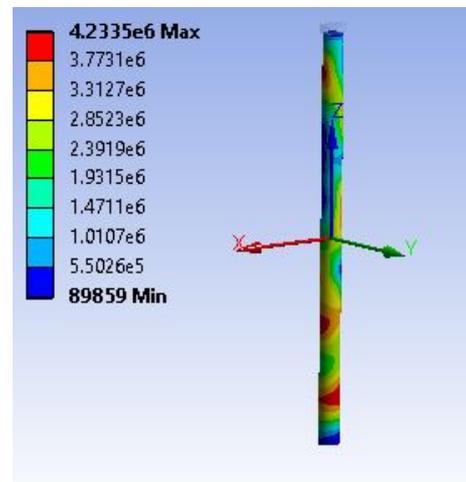


Figure 45 Von Mises stress diagram for step 79

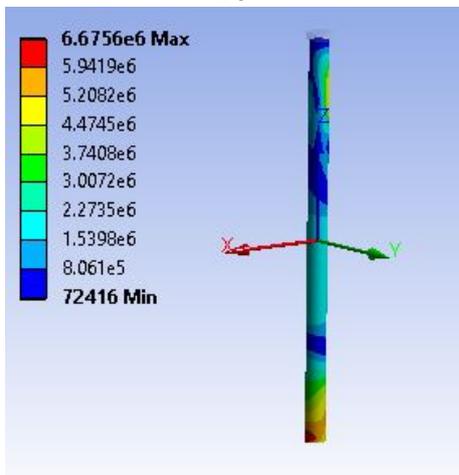


Figure 43 Von Mises stress diagram for step 75

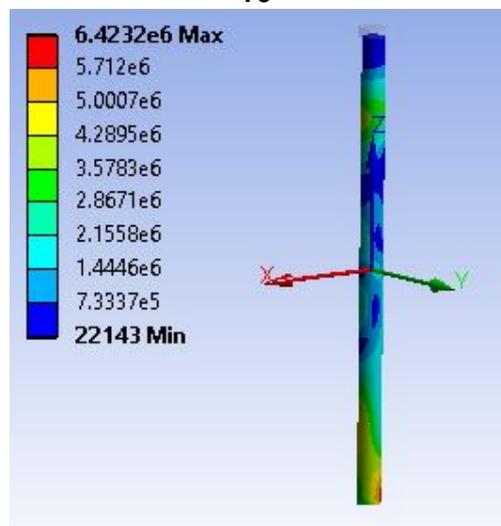


Figure 46 Von Mises stress diagram for step 81

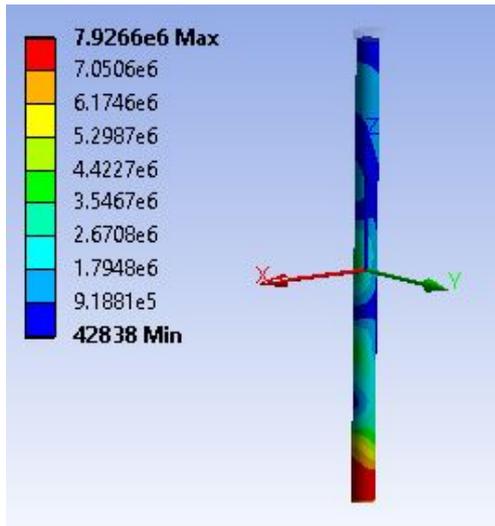


Figure 47 Von Mises stress diagram for step 83

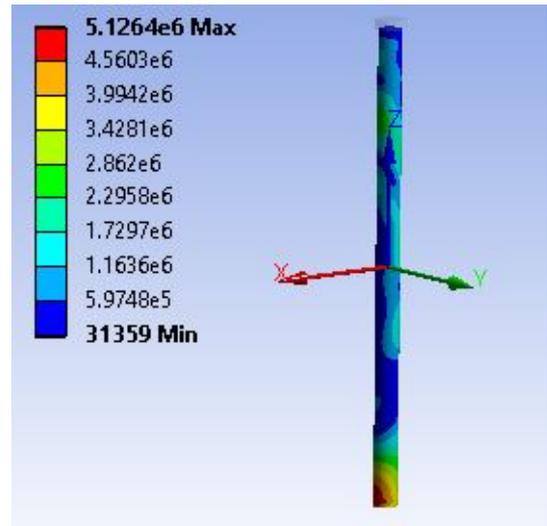


Figure 50 Von Mises stress diagram for step 89

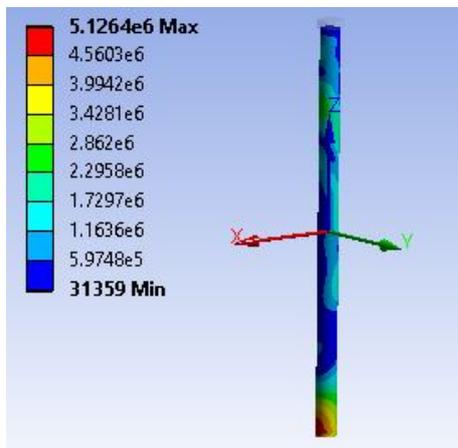


Figure 48 Von Mises stress diagram for step 85

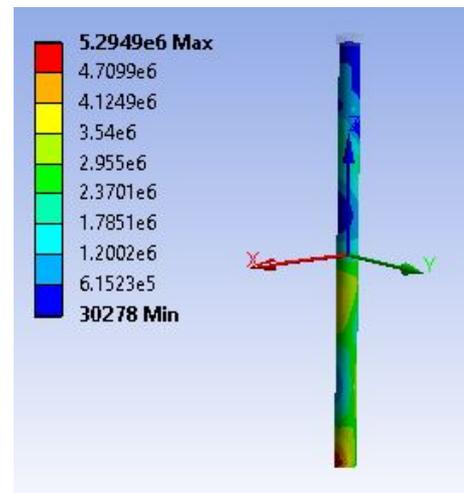


Figure 51 Von Mises stress diagram for step 91

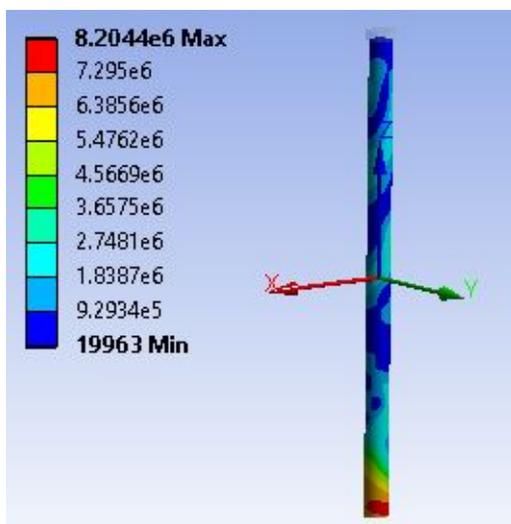


Figure 49 Von Mises stress diagram for step 87

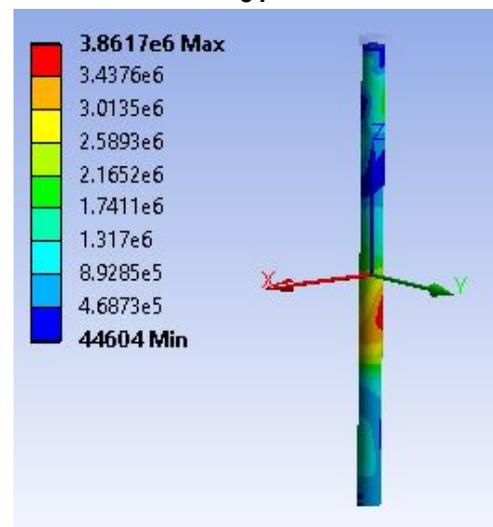


Figure 52 Von Mises stress diagram for step 93

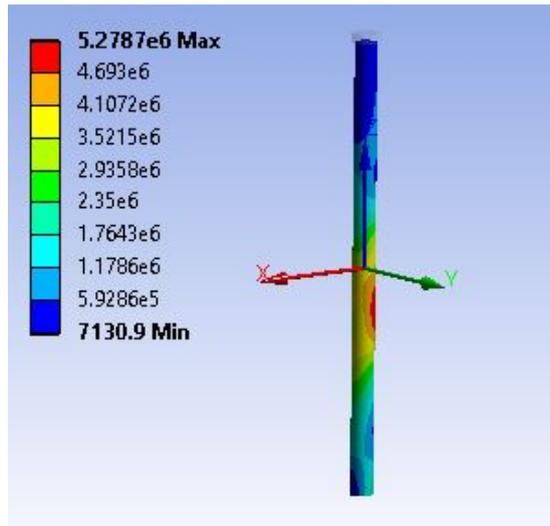


Figure 53 Von Mises stress diagram for step 95

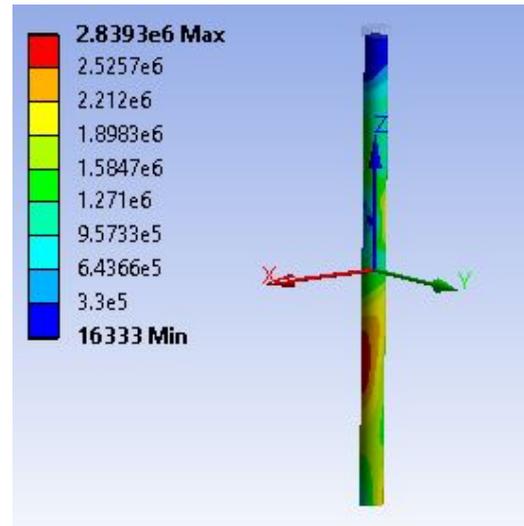


Figure 55 Von Mises stress diagram for step 99

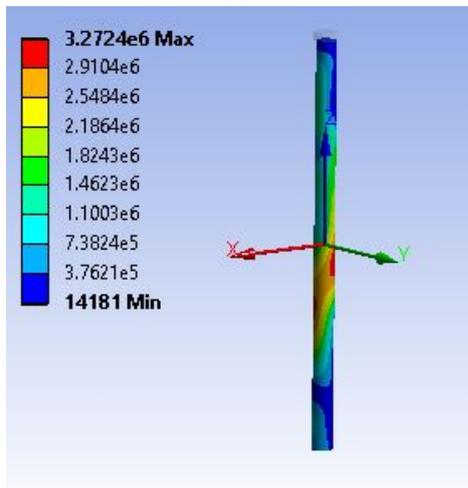


Figure 54 Von Mises stress diagram for step 97

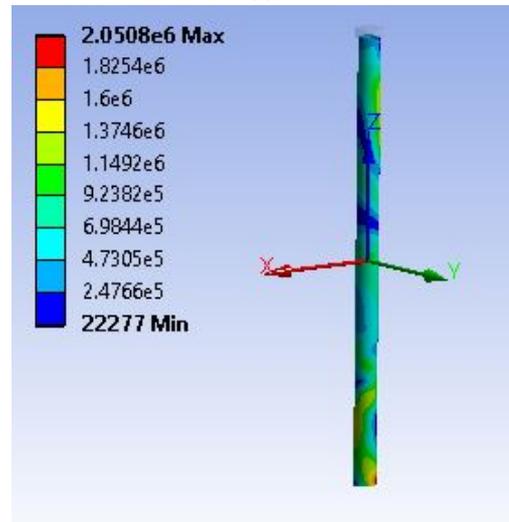


Figure 56 Von Mises stress diagram for step 101

CONCLUSIONS

The maximum value for the von Mises stress is reached at step 2 (0.01 seconds) and the value is $77.863 \text{ [N/mm}^2\text{]}$.

BIBLIOGRAPHY

- [1] www.ansys.com
- [2] www.vulcanhammer.info