Comparison of TM vs SM with respect to plastic strain

Materials used:

SM: LinearStrainHardening
TM: ComputeElasticityTensor, ComputeFiniteStrain, ComputeMultiPlasticityStress

Also, TM UserObjects: TensorMechanicsHardeningConstant, TensorMechanicsPlasticJ2

Material properties:

SM: hardening constant = 0, young's modulus = 2.1e5, poisson = 0.3, yield stress = 2.42e2
TM: C_ijkl = '121154 80769.2' (lambda, G), yield stress = 2.42e2 (TMHardeningConstant value); plastic model j2

Problem set up:

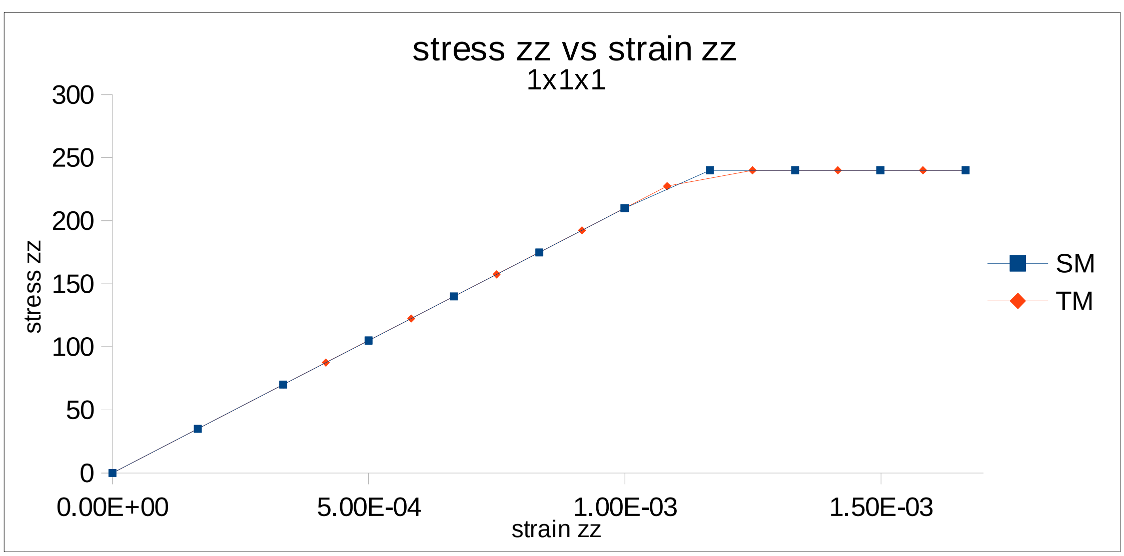
– Generated mesh, spanning -0.5 to 0.5 in all three dimensions (1x1x1 block).
– Constrained at x = 0, y = 0, z = 0; Pulled in z direction on front at rate of disp_z = t/60.
– Executioner: end_time = 0.1, dt = 0.01
– Initially started with larger disp_z = t, but could not see plastic region (all stress_zz values were the same except at t = 0). The final disp_z with this set up is 0.1/60 = 0.002, corresponding to a true strain of 1.665e-3.

Variables:

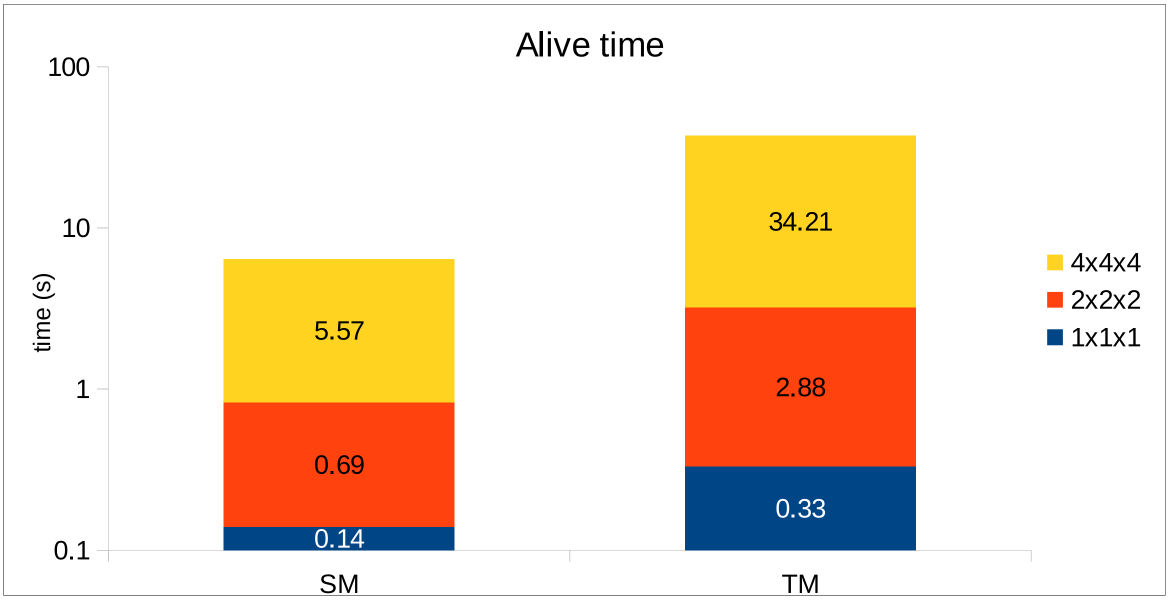
TM vs SM + Mesh size: number of elements = 1x1x1, 2x2x2, and 4x4x4 (three test cases)

Results:

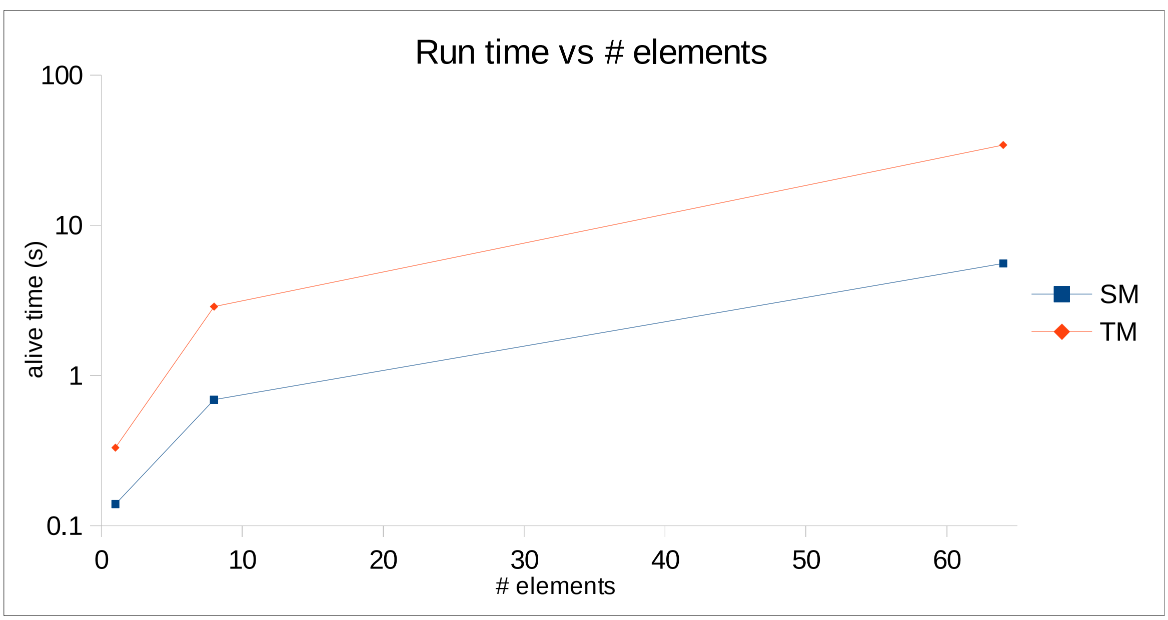
All stress_zz vs strain_zz plots looked identical for TM vs SM, except with 1x1x1 in TM, the jump from t = 0.02 to 0.03 fails to converge; therefore, step size is reduced to dt = 0.005. Values still match the same trend, but TM results show in-between points. See plot below.



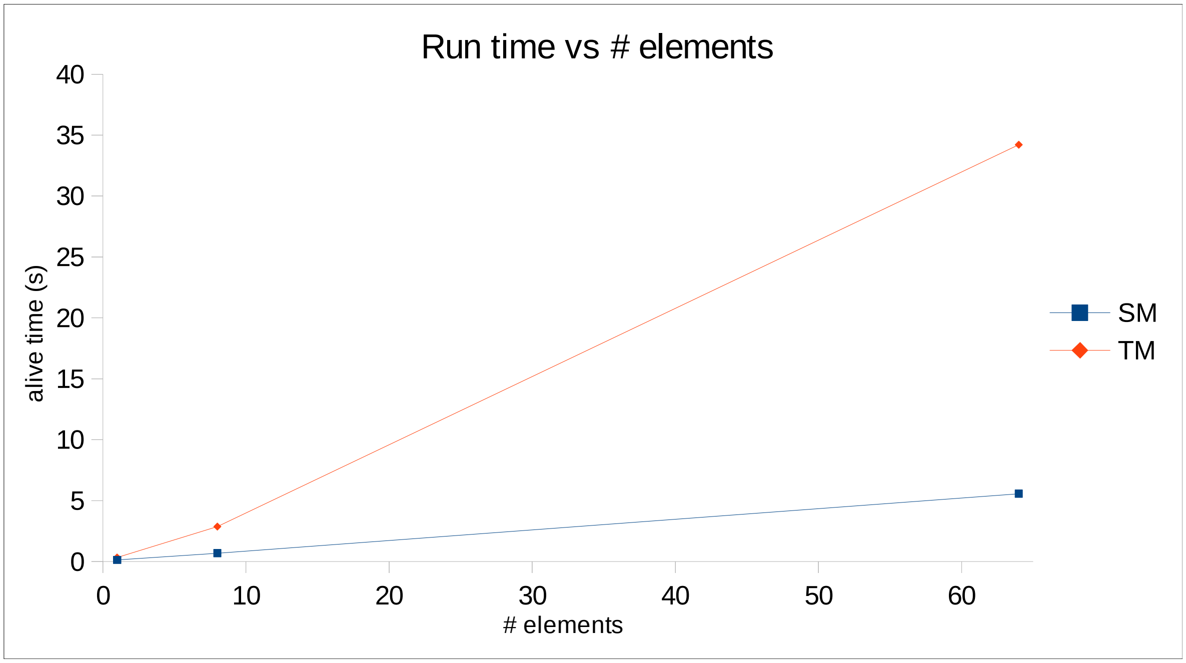
Next, a comparison was done for run time versus number of elements, for SM versus TM. See plot below. 1x1x1 mesh indicates 1 element; 2x2x2 mesh indicates 8 elements; 4x4x4 mesh indicates 64 elements. Note results are plotted on a log scale for visibility.



Alternative view below.



And with a non log scale on next page.



Run time vs # elements
alive time (s)
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
elements
SM
TM