Verification tests for the simplified geomodel

This document presents some single-element tests which were considered as the verification tests for the implementation of the simplified geomodel into Uintah.

Verification Test 1

Problem description:

A linear Drucker-Prager yield function is considered. The single element is deformed based on an input strain path. Parameters and the strain path used in this single-element test are given in Tables 4 and 5 of the following paper:

Brannon, R.M., Leelavanichkul S. "A multi-stage return algorithm for solving the classical damage component of constitutive models for rocks, ceramics, and other rock-like media", International Journal of Fracture, 2010, vol. 163, pp. 133-149.

Results:

Figure 1: Obtained stress path from the Uintah simulation is in a very good agreement with the analytical stress path.

Figure 2: Obtained time histories of the stress components from the Uintah simulation are in a very good agreement with the analytical results.

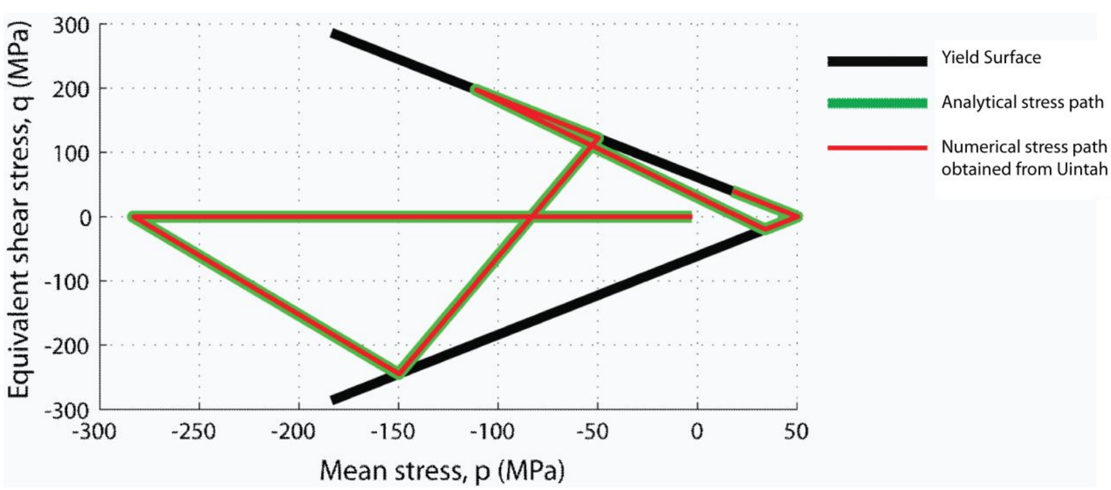

Figure 1. Stress path for verification test 1

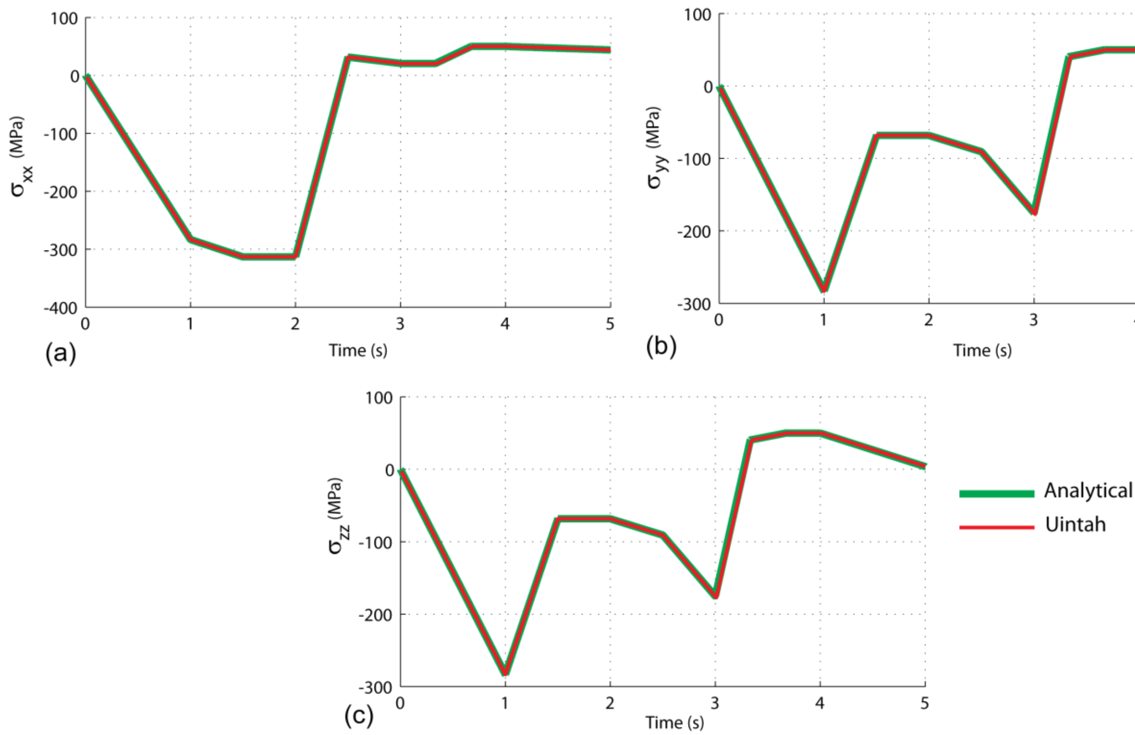

Figure 2. Time histories of the stress components for verification test 1

Verification Test 2

Problem description:

The yield surface includes both the linear Drucker-Prager and cap parts. No hardening or cap evolution is considered in this simulation. The single element is deformed under uniaxial strain compression.

Results:

Figure 3: Obtained stress path from the Uintah simulation remained on the yield surface after yielding. The obtained results are qualitatively correct.

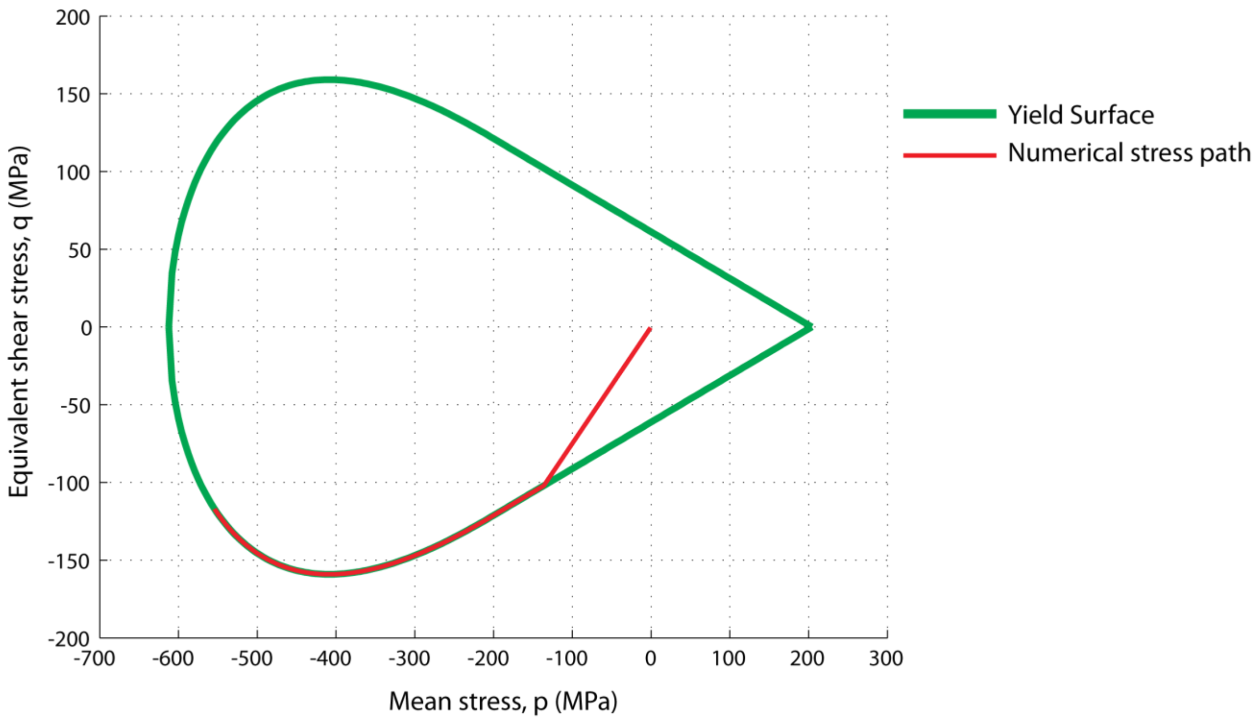

Figure 3. Stress path for verification test 2

Verification Test 3

Problem description:

The yield surface includes both the linear Drucker-Prager and cap parts. No hardening or cap evolution is considered in this simulation. The single element is deformed under hydrostatic compression.

Results:

Figure 4: Obtained stress path from the Uintah simulation remained on the yield surface after yielding. The obtained results are qualitatively correct.

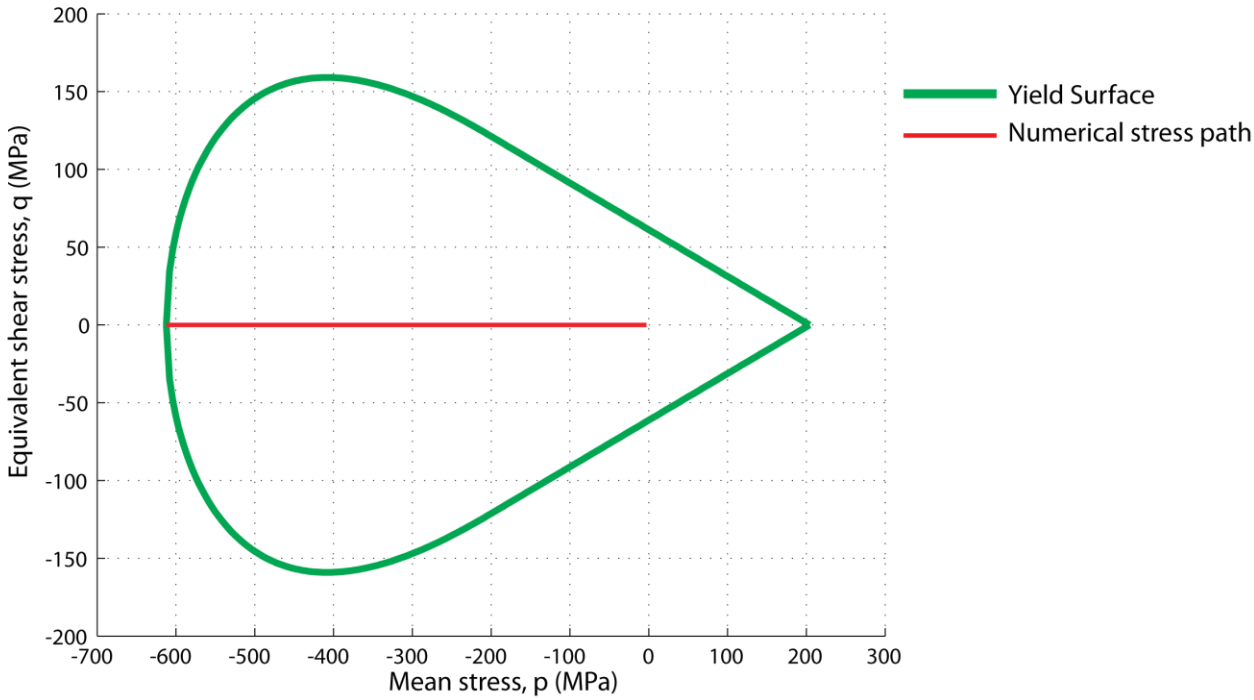

Figure 4. Stress path for verification test 3

Verification Test 4

Problem description:

The yield surface includes both the linear Drucker-Prager and cap parts. Hardening and cap evolution are considered in this simulation. The single element is deformed under uniaxial strain compression.

Results:

Figure 5: Obtained stress path from the Uintah simulation are qualitatively correct.

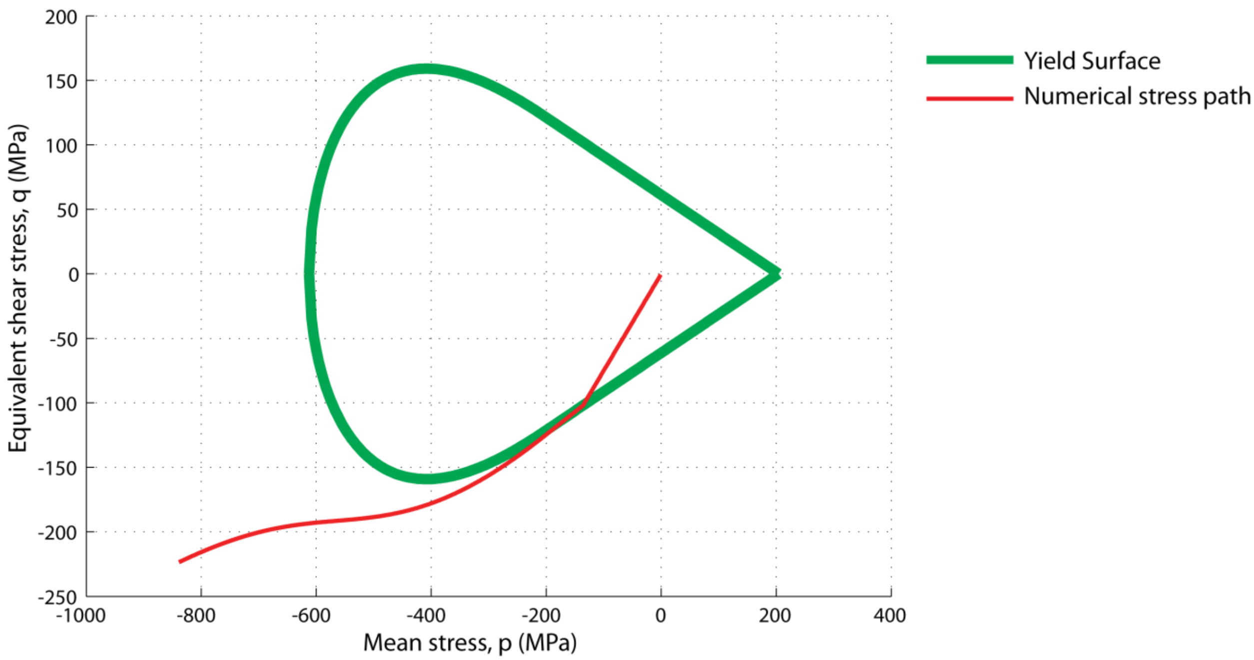

Figure 5. Stress path for verification test 4

Verification Test 5

Problem description:

The yield surface includes both the linear Drucker-Prager and cap parts. Hardening and cap evolution are considered in this simulation. The single element is deformed under hydrostatic compression.

Results:

Figure 6: Obtained stress path from the Uintah simulation are qualitatively correct.

Figure 7: Obtained crush curve from the Uintah simulation is in a very good agreement with the analytical crush curve.

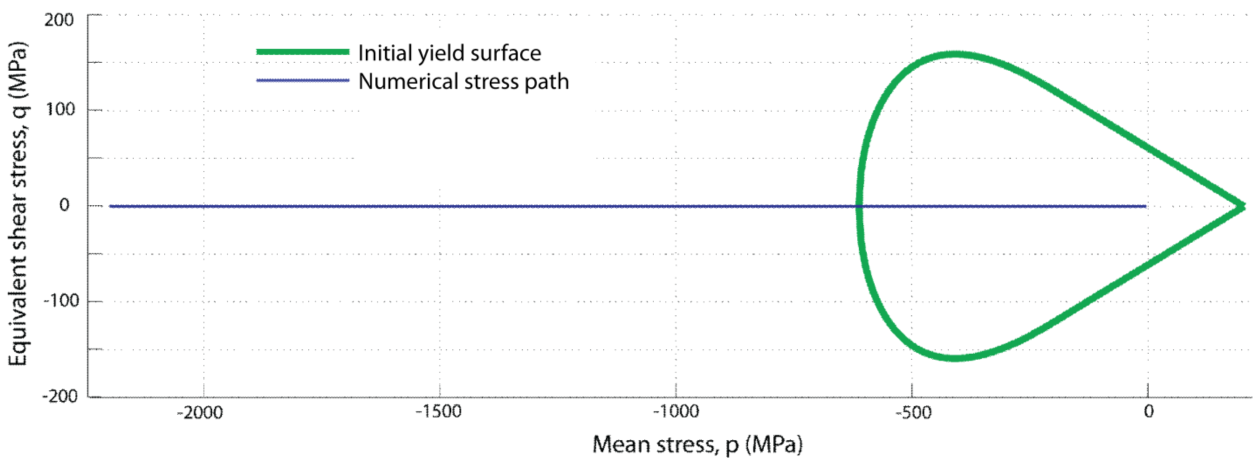

Figure 6. Stress path for verification test 5

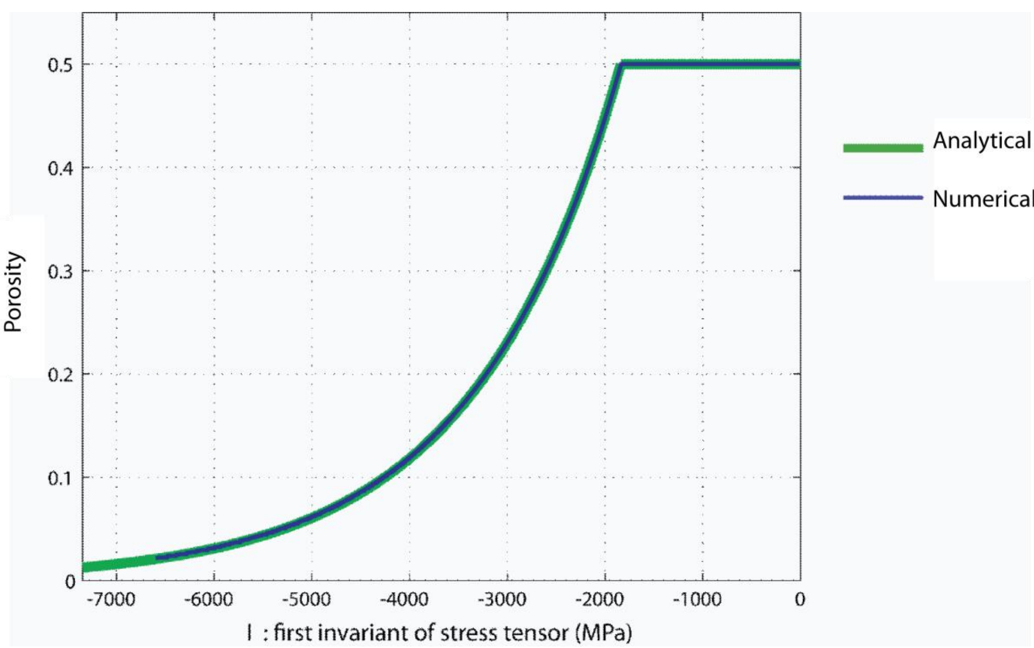

Figure 7. Crush curve for verification test 5

Verification Test 6

Problem description:

The yield surface includes both the linear Drucker-Prager and cap parts. Hardening and cap evolution are considered in this simulation. The single element is deformed under hydrostatic loading/unloading. The following deformation gradient table is applied on the single element.

Time(s)	F_{11}	F_{12}	F_{13}	F_{21}	F_{22}	F_{23}	F_{31}	F_{32}	F_{33}
0.0	1.00	0	0	0	1.00	0	0	0	1.00
1.0	0.93	0	0	0	0.93	0	0	0	0.93
2.0	1.00	0	0	0	1.00	0	0	0	1.00
3.0	0.92	0	0	0	0.92	0	0	0	0.92

Results:

Figure 8: Obtained pressure versus volumetric part of strain diagram from the Uintah simulation is qualitatively correct.

Figure 9: Obtained Time history of κ (κ is a parameter that defines the position of the cap. See Kayenta's user guide for more information.) from the Uintah simulation is qualitatively correct.

Figure 10: Obtained crush curve from the Uintah simulation for the loading part is in a very good agreement with the analytical crush curve.

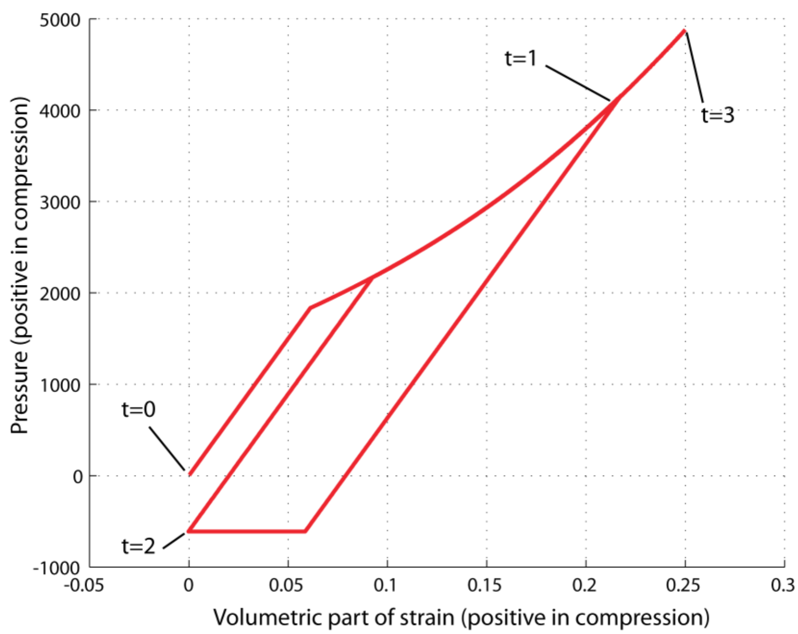

Figure 8. pressure versus volumetric part of strain diagram for verification test 6

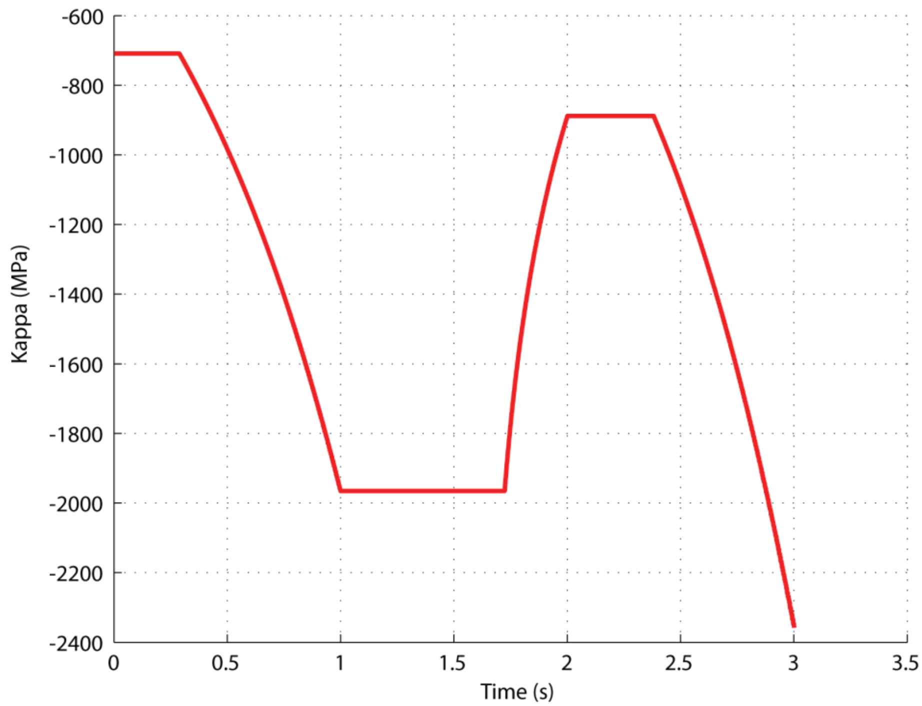

Figure 9. Time history of kappa for verification test 6

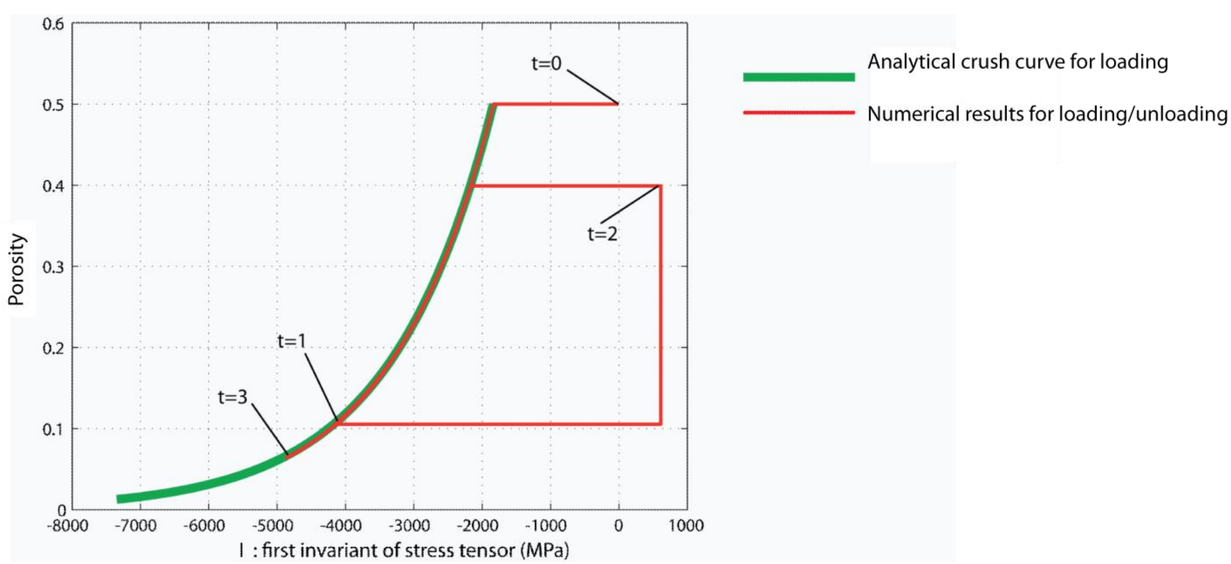

Figure 10. Crush curve for verification test 6

Verification Test 7

Problem description:

The yield surface includes both the linear Drucker-Prager and cap parts. Hardening and cap evolution are considered in this simulation. The single element is deformed under hydrostatic compression. The effective stress model developed by Michael Homel and Dr. Brannon is examined in this test.

Results:

Figure 11: Obtained crush curves from the Uintah simulations show the correct trend for the fluid effects.

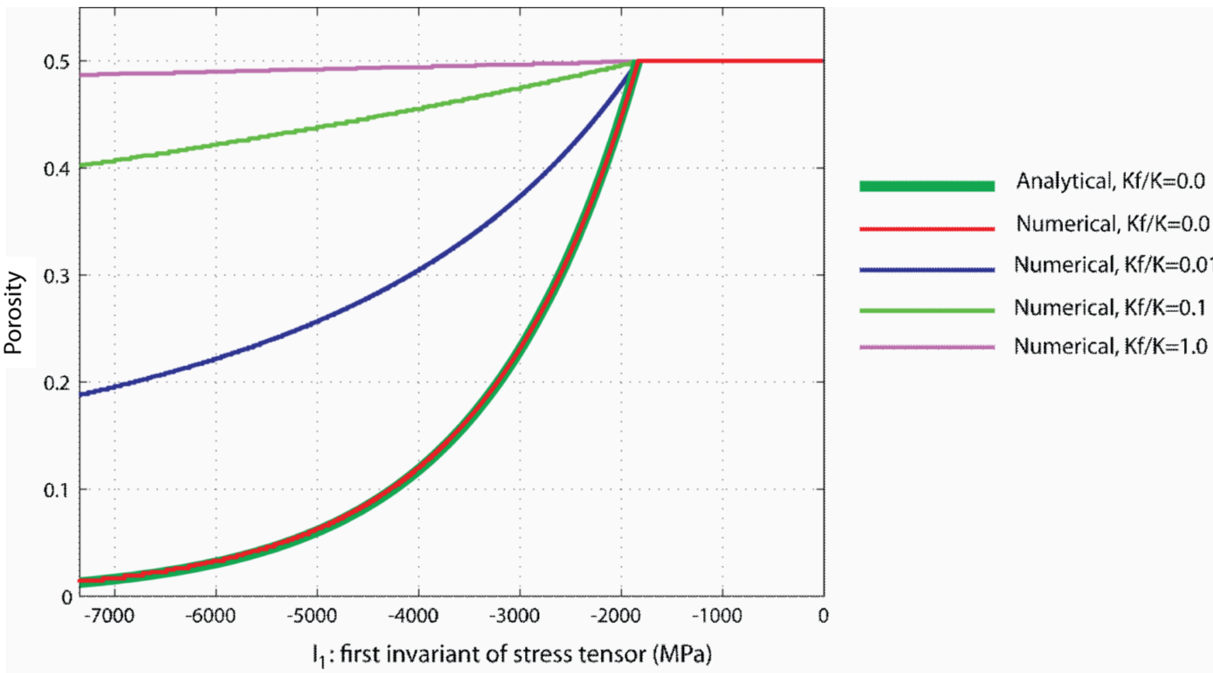

Figure 11. Crush curve for verification test 7

Verification Test 8

Problem description:

The von Mises yield criterion is considered. Three cases are examined: no hardening, isotropic hardening, and kinematic hardening. The single element is deformed under uniaxial strain loading/unloading.

Results:

Figure 12: Obtained stress paths from the Uintah simulations show the correct trend.

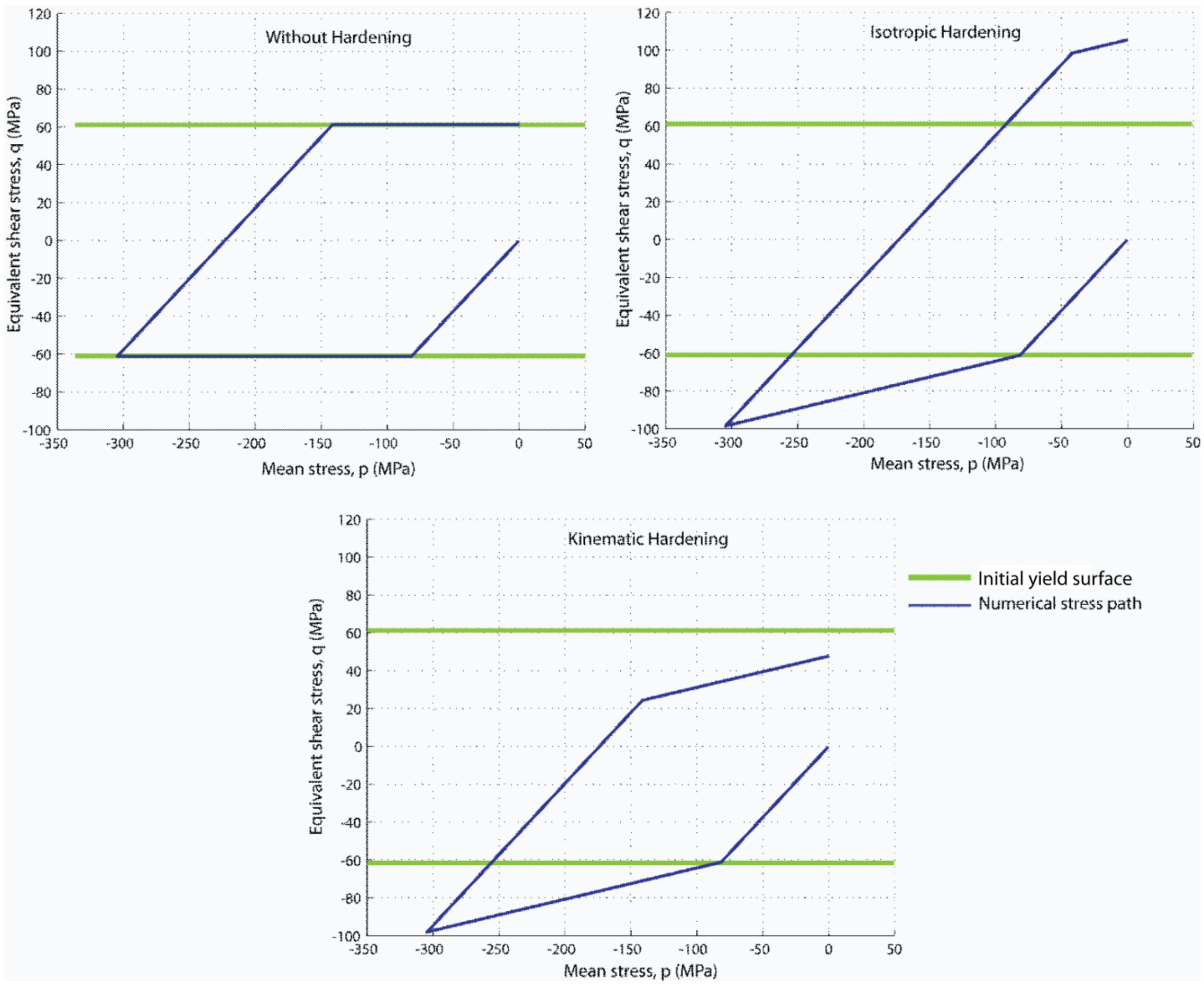

Figure 12. Stress path for verification test 8