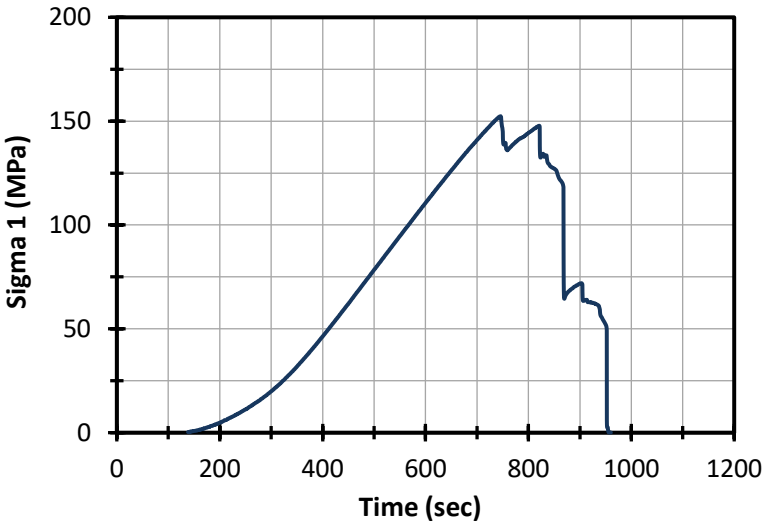
Attachment B –

Compression Test Data

Uniaxial Compression Strength Test: BC-81-2-1U

Axial Stress - Time



Test and Specimen Data:

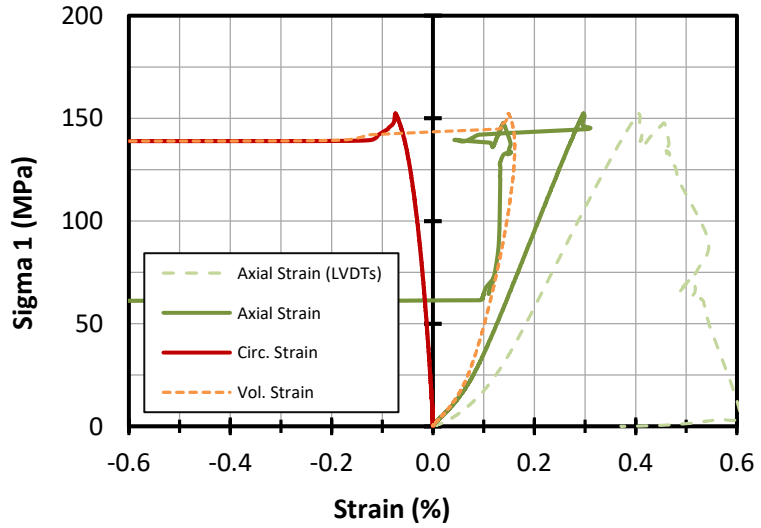
Specimen ID:	**BC-81-2-1U**	**Moisture Condition:**	dry
Depth (m):	17.56	**Test Completed on:**	21-Feb-19
Length (mm):	105.03	**Load Control:**	axial displ.
Diameter (mm):	47.48	**Loading Rate (mm/s):**	0.0007

Test Results:

Peak Strength (MPa) | **152.4**

	mechanical	*electrical*
Axial Strain at Peak (%)	0.406	0.297
Maximum Volumetric Strain (%)	--	0.162
Young's Modulus, E (GPa)	48.7	61.5
Poisson's Ratio, v	--	0.23

Stress - Strain Curves



Failure Description:

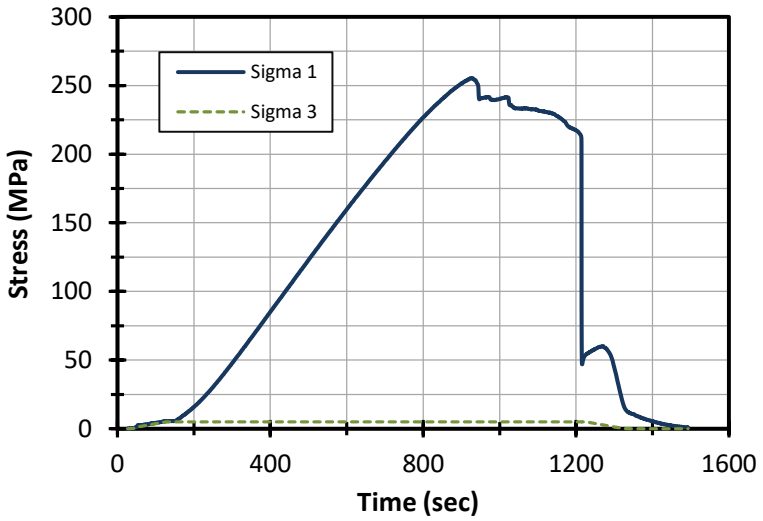
- massive/planar shear

Notes:

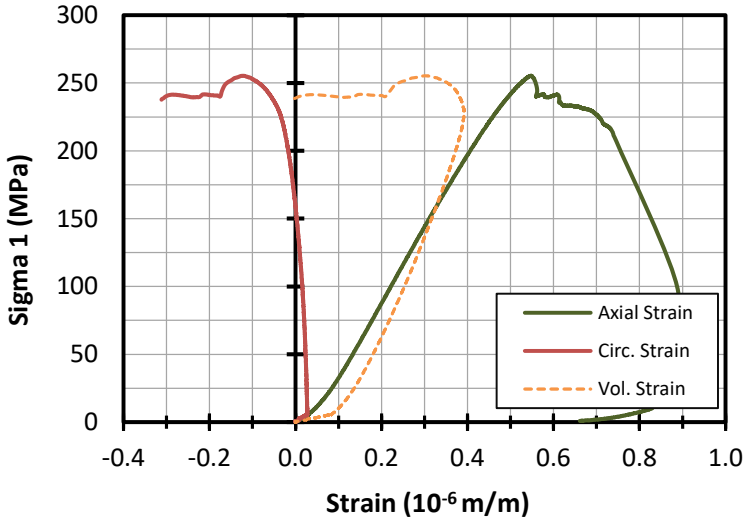
- Testing completed in accordance with ASTM D7012-14
- Elastic properties estimated over the range of 45-55% of peak strength
- "--" = no data/not available

Triaxial Compression Strength Test: BC-81-2-2T

Stress - Time



Stress - Strain Curves



Test and Specimen Data:

Specimen ID:	**BC-81-2-2T**	**Moisture Condition:**	dry
Rock Type:	sandstone	**Test Completed on:**	11-Mar-19
Length (mm):	105.02	**Load Control:**	axial
Diameter (mm):	47.50	**Loading Rate (mm/s):**	0.0007

Confinement (MPa)	**5.0**

Test Results:

Peak Strength (MPa)	255.3
Axial Strain at Peak (%)	0.547
Maximum Volumetric Strain (%)	0.392
Young's Modulus, E (Gpa)	56.1
Poisson's Ratio	0.15

Failure Description:

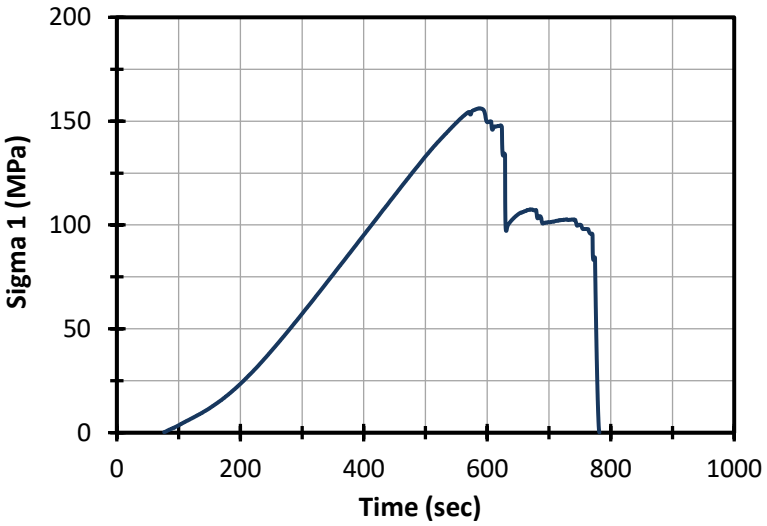
- multiple shear, massive/crushing along horizontal plane in upper 1/3 of sample

Notes:

- Testing completed in accordance with ASTM D7012-14
- Elastic properties estimated over the range of 45-55% of peak strength

Uniaxial Compression Strength Test: BC-81-2-3U

Axial Stress - Time



Test and Specimen Data:

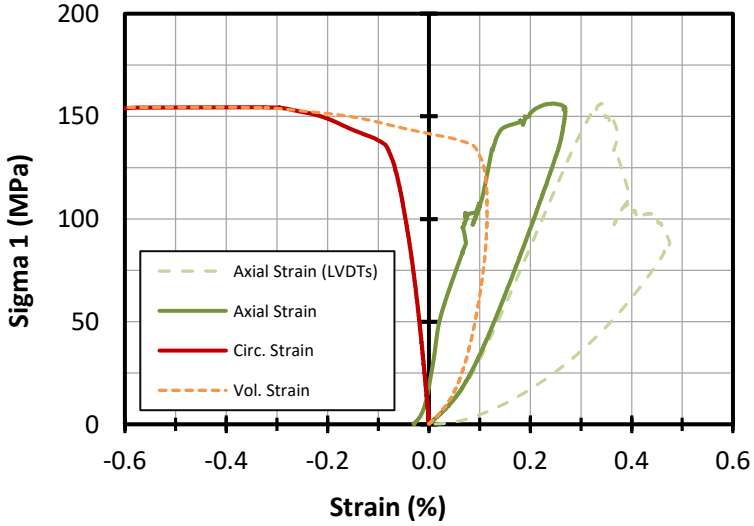
Specimen ID:	BC-81-2-3U	**Moisture Condition:**	dry
Depth (m):	29.58	**Test Completed on:**	21-Feb-19
Length (mm):	105.01	**Load Control:**	axial displ.
Diameter (mm):	47.27	**Loading Rate (mm/s):**	0.0007

Test Results:

Peak Strength (MPa)	**156.2**

	mechanical	*electrical*
Axial Strain at Peak (%)	0.341	0.244
Maximum Volumetric Strain (%)	--	0.115
Young's Modulus, E (GPa)	57.2	64.5
Poisson's Ratio, v	--	0.36

Stress - Strain Curves



Failure Description:

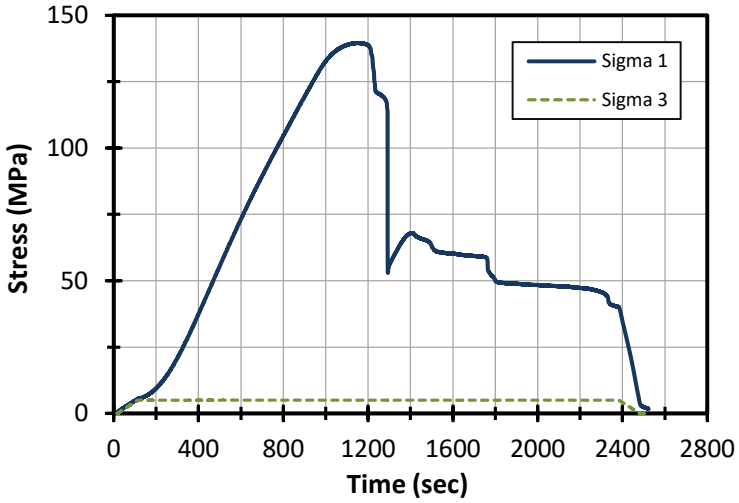
- massive shear

Notes:

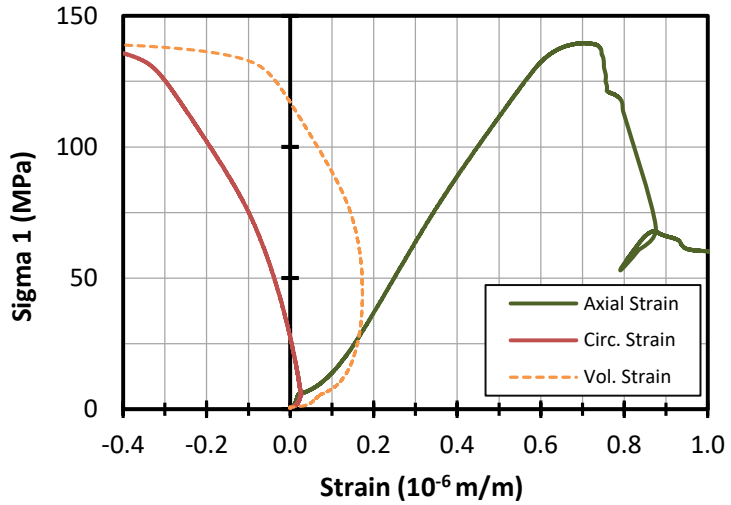
- Testing completed in accordance with ASTM D7012-14
- Elastic properties estimated over the range of 45-55% of peak strength
- "--" = no data/not available

Triaxial Compression Strength Test: BC-81-2-4T

Stress - Time



Stress - Strain Curves



Test and Specimen Data:

Specimen ID:	**BC-81-2-4T**	**Moisture Condition:**	dry
Rock Type:	sandstone	**Test Completed on:**	11-Mar-19
Length (mm):	105.03	**Load Control:**	axial
Diameter (mm):	47.14	**Loading Rate (mm/s):**	0.0007

Confinement (MPa) | **5.0**

Test Results:

Peak Strength (MPa)	139.6
Axial Strain at Peak (%)	0.705
Maximum Volumetric Strain (%)	0.173
Young's Modulus, E (GPa)	26.0
Poisson's Ratio	nd

Failure Description:

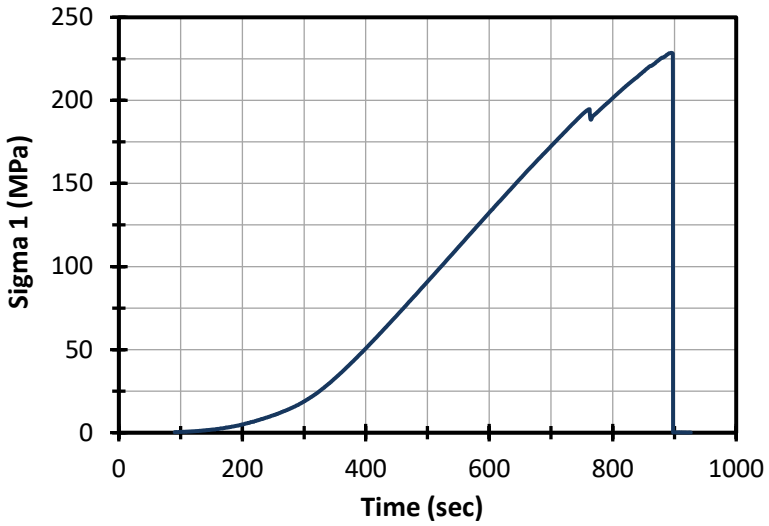
- planar shear, FA = 65°

Notes:

- Testing completed in accordance with ASTM D7012-14
- Elastic properties estimated over the range of 45-55% of peak strength

Uniaxial Compression Strength Test: BC-81-2-5U

Axial Stress - Time



Test and Specimen Data:

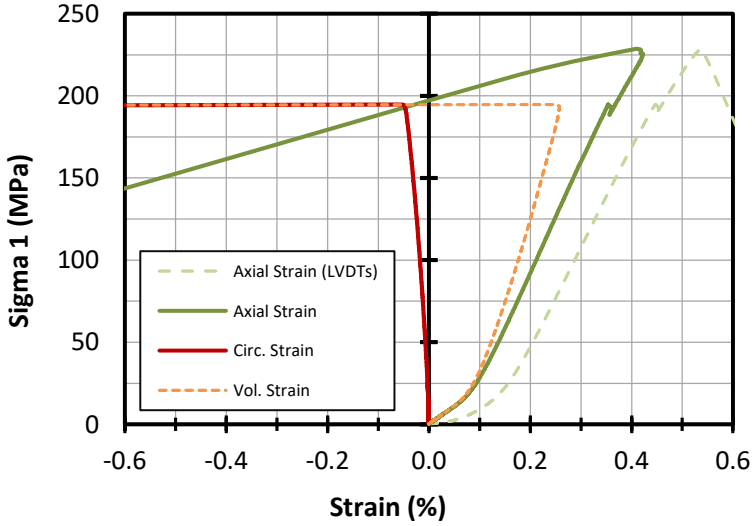
Specimen ID:	BC-81-2-5U	**Moisture Condition:**	dry
Depth (m):	47.60	**Test Completed on:**	21-Feb-19
Length (mm):	105.01	**Load Control:**	axial displ.
Diameter (mm):	47.38	**Loading Rate (mm/s):**	0.0007

Test Results:

Peak Strength (MPa)	**194.7** *

	mechanical	*electrical*
Axial Strain at Peak (%)	0.448	0.354
Maximum Volumetric Strain (%)	--	0.258
Young's Modulus, E (GPa)	62.0	68.3
Poisson's Ratio, v	--	0.16

Stress - Strain Curves



Failure Description:

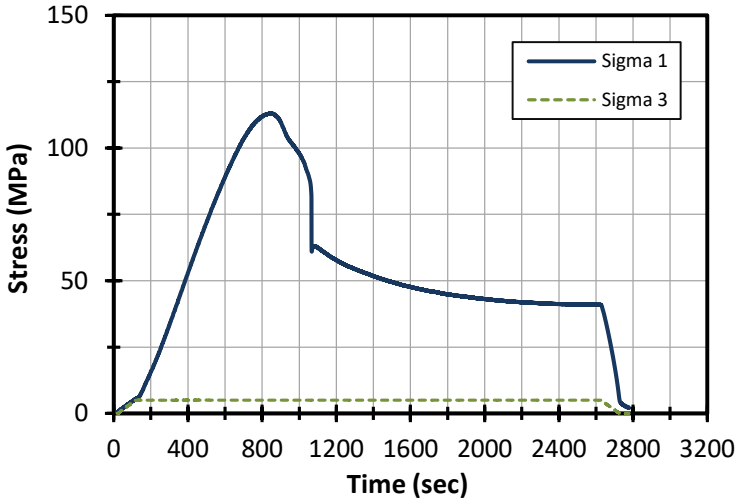
-massive shear, vertical splitting

Notes:

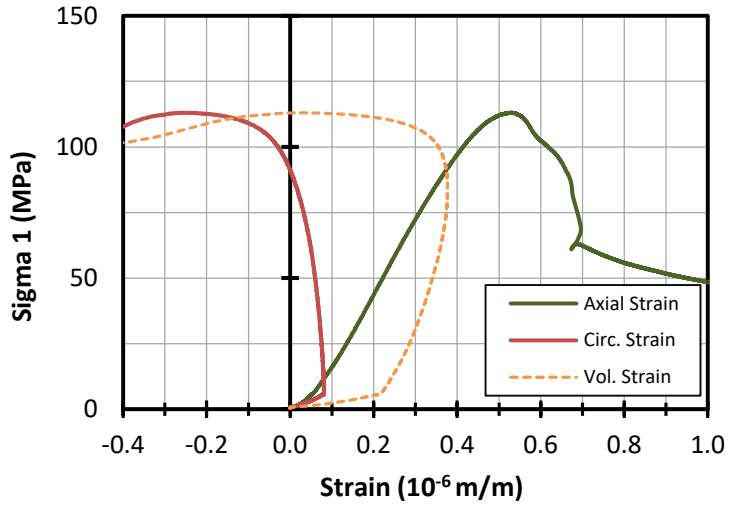
- Testing completed in accordance with ASTM D7012-14
- Elastic properties estimated over the range of 45-55% of peak strength
- "--" = no data/not available
- "*" = peak strength estimated as initial drop in axial stress and corresponding rapid change in circular strain

Triaxial Compression Strength Test: BC-81-2-6T

Stress - Time



Stress - Strain Curves



Test and Specimen Data:

Specimen ID:	**BC-81-2-6T**	**Moisture Condition:**	dry
Rock Type:	sandstone	**Test Completed on:**	12-Mar-19
Length (mm):	104.95	**Load Control:**	axial
Diameter (mm):	47.38	**Loading Rate (mm/s):**	0.0007

Confinement (MPa)	**5.0**

Test Results:

Peak Strength (MPa)	113.0
Axial Strain at Peak (%)	0.531
Maximum Volumetric Strain (%)	0.377
Young's Modulus, E (GPa)	29.1
Poisson's Ratio	0.26

Failure Description:

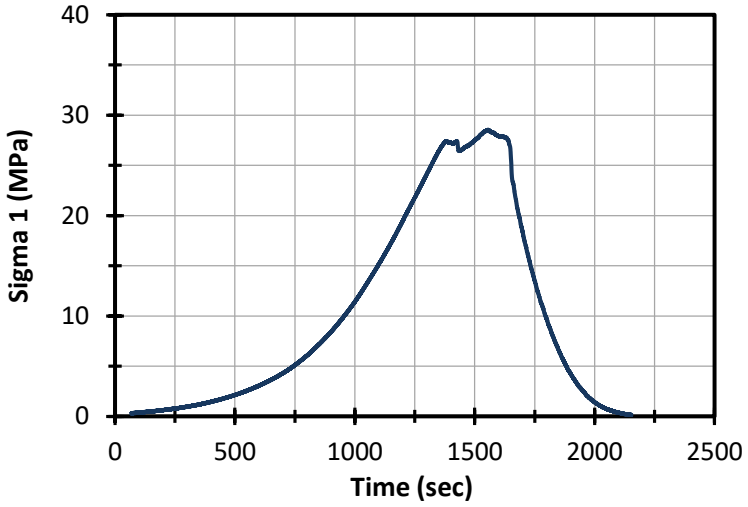
- undulating shear, FA = 60°

Notes:

- Testing completed in accordance with ASTM D7012-14
- Elastic properties estimated over the range of 45-55% of peak strength

Uniaxial Compression Strength Test: BC-81-2-66.71-U

Axial Stress - Time



Test and Specimen Data:

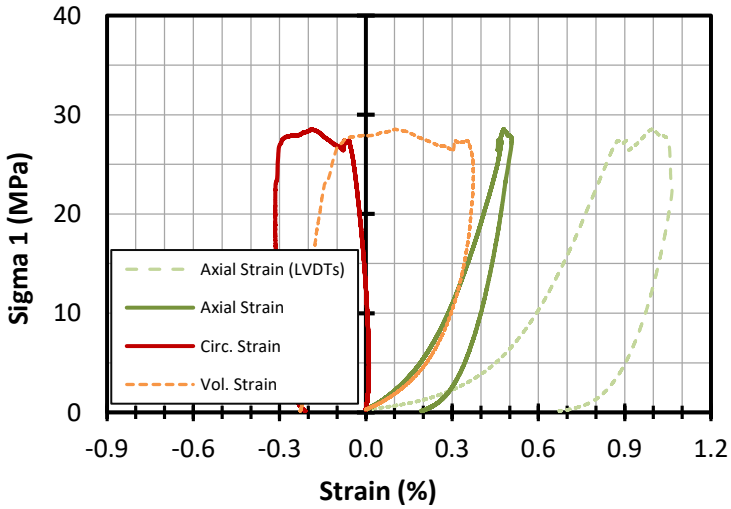
Specimen ID:	BC-81-2-66.71-U	**Moisture Condition:**	dry
Depth (m):	66.71	**Test Completed on:**	14-Feb-20
Length (mm):	104.85	**Load Control:**	axial displ.
Diameter (mm):	47.42	**Loading Rate (mm/s):**	0.0007

Test Results:

Peak Strength (MPa)	**27.4** *

	mechanical	*electrical*
Axial Strain at Peak (%)	0.875	0.470
Maximum Volumetric Strain (%)	0.754	0.374
Young's Modulus, E (GPa)	5.7	7.9
Poisson's Ratio, v	0.07	0.19

Stress - Strain Curves



Failure Description:

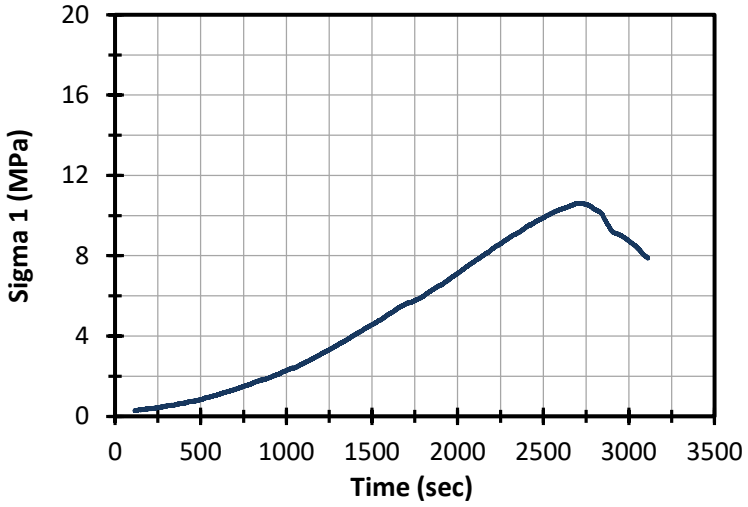
-undulating shear, FA = 60°

Notes:

- Weathered sample with pre-existing internal defects; hydrostone used to fill sample ends
- Testing completed in accordance with ASTM D7012-14
- Elastic properties estimated over the range of 45-55% of peak strength

Uniaxial Compression Strength Test: BC-81-2-66.99-U

Axial Stress - Time



Test and Specimen Data:

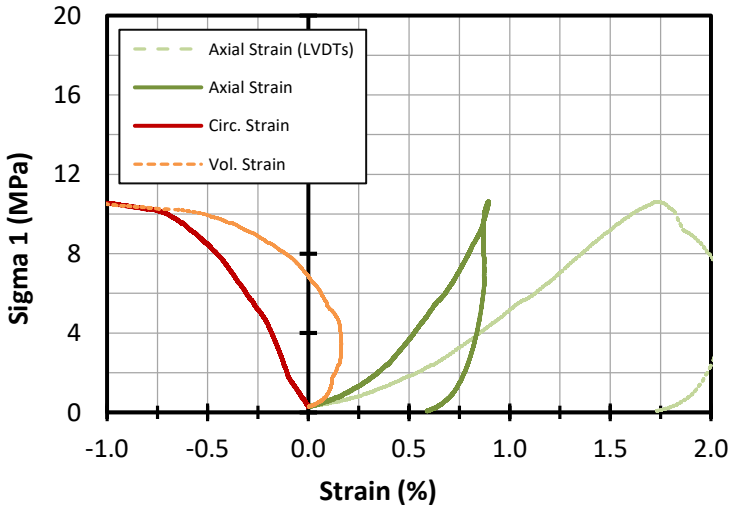
Specimen ID:	BC-81-2-66.99-U	**Moisture Condition:**	dry
Depth (m):	66.99	**Test Completed on:**	14-Feb-20
Length (mm):	104.88	**Load Control:**	axial displ.
Diameter (mm):	47.50	**Loading Rate (mm/s):**	0.0007

Test Results:

Peak Strength (MPa) **10.6** *

	mechanical	*electrical*
Axial Strain at Peak (%)	1.729	0.895
Maximum Volumetric Strain (%)	0.899	0.165
Young's Modulus, E (GPa)	0.7	1.3
Poisson's Ratio, v	0.30	nd

Stress - Strain Curves



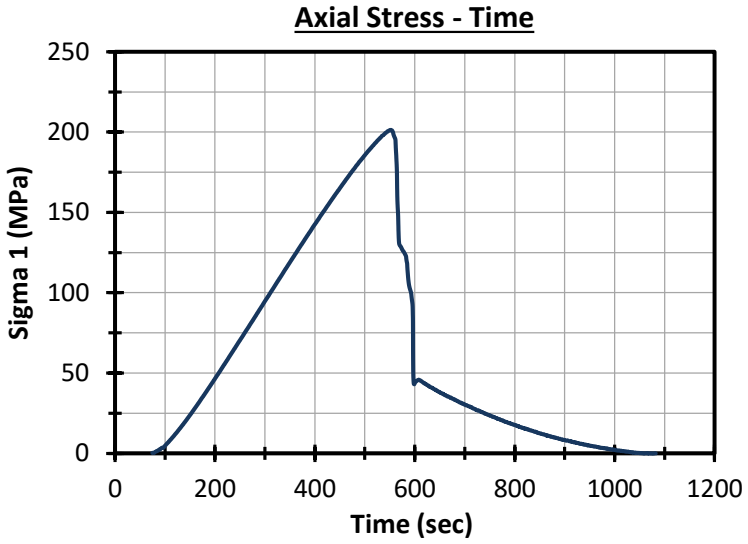
Failure Description:

-axial splitting

Notes:

- Weathered sample with pre-existing internal defects; hydrostone used to fill sample ends
- Testing completed in accordance with ASTM D7012-14
- Elastic properties estimated over the range of 45-55% of peak strength
- "nd" = could not be determined

Uniaxial Compression Strength Test: BC-81-2-70.94-U



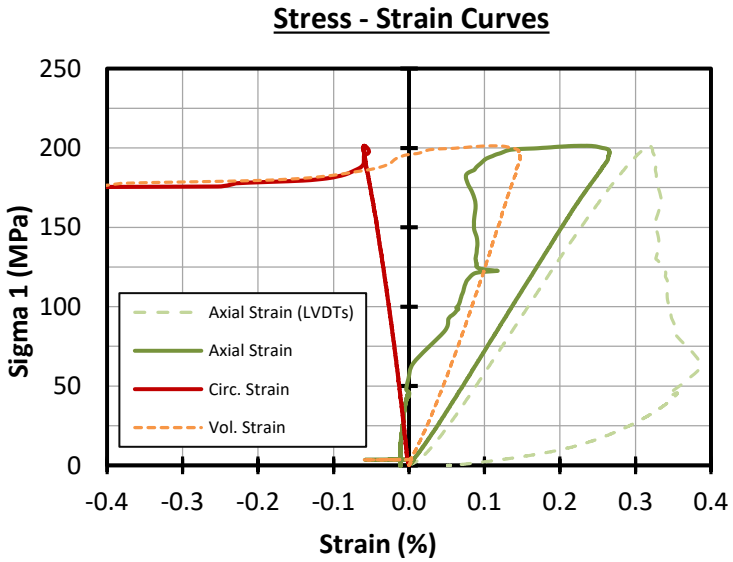
Test and Specimen Data:

Specimen ID:	BC-81-2-70.94-U	**Moisture Condition:**	dry
Depth (m):	70.94	**Test Completed on:**	14-Feb-20
Length (mm):	104.97	**Load Control:**	axial displ.
Diameter (mm):	47.36	**Loading Rate (mm/s):**	0.0007

Test Results:

Peak Strength (MPa)	**201.4**

	mechanical	*electrical*
Axial Strain at Peak (%)	0.318	0.236
Maximum Volumetric Strain (%)	0.167	0.147
Young's Modulus, E (GPa)	72.8	76.7
Poisson's Ratio, v	0.19	0.23



Failure Description:

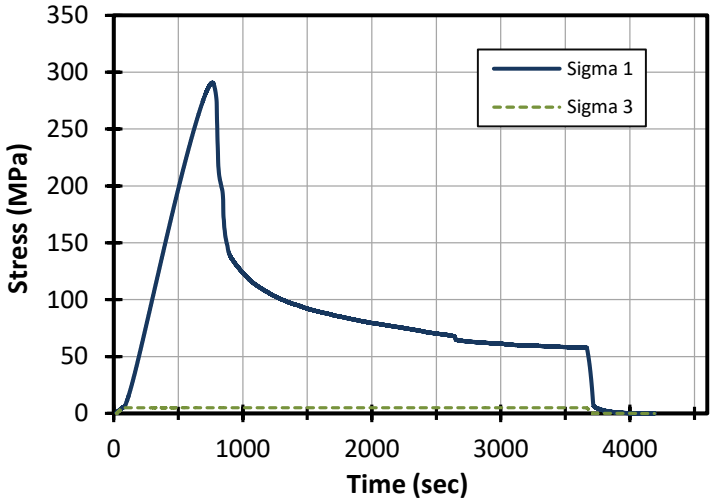
-axial splitting, multiple fractures

Notes:

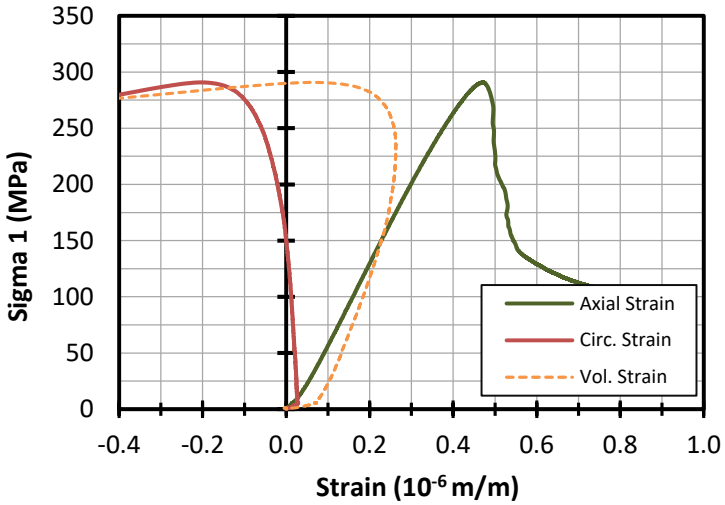
- Testing completed in accordance with ASTM D7012-14
- Elastic properties estimated over the range of 45-55% of peak strength

Triaxial Compression Strength Test: BC-81-2-71.09-T

Stress - Time



Stress - Strain Curves



Test and Specimen Data:

Specimen ID:	**BC-81-2-71.09-T**	**Moisture Condition:**	dry
Rock Type:	sandstone	**Test Completed on:**	12-Mar-20
Length (mm):	104.98	**Load Control:**	axial
Diameter (mm):	47.36	**Loading Rate (mm/s):**	0.0007

Confinement (MPa)	**5.0**

Test Results:

Peak Strength (MPa)	290.8
Axial Strain at Peak (%)	0.471
Maximum Volumetric Strain (%)	0.263
Young's Modulus, E (GPa)	72.9
Poisson's Ratio	0.20

Failure Description:

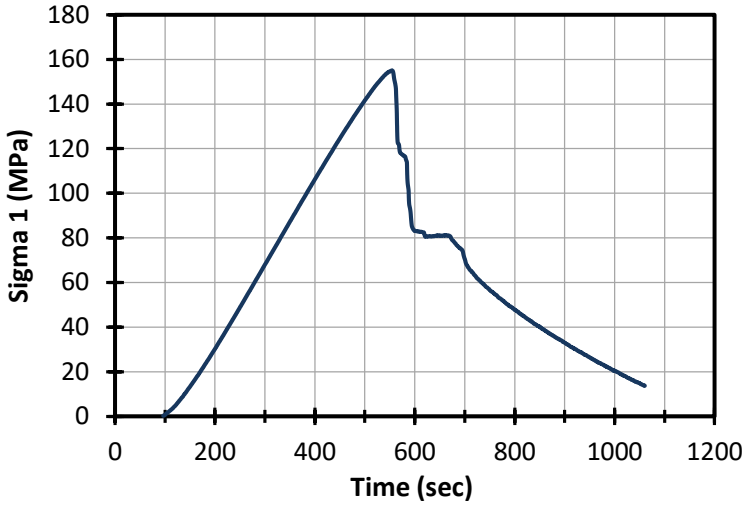
- massive shear (60^{o}) and axial splitting

Notes:

- Testing completed in accordance with ASTM D7012-14
- Elastic properties estimated over the range of 45-55% of peak strength

Uniaxial Compression Strength Test: BC-81-2-71.09-U

Axial Stress - Time



Test and Specimen Data:

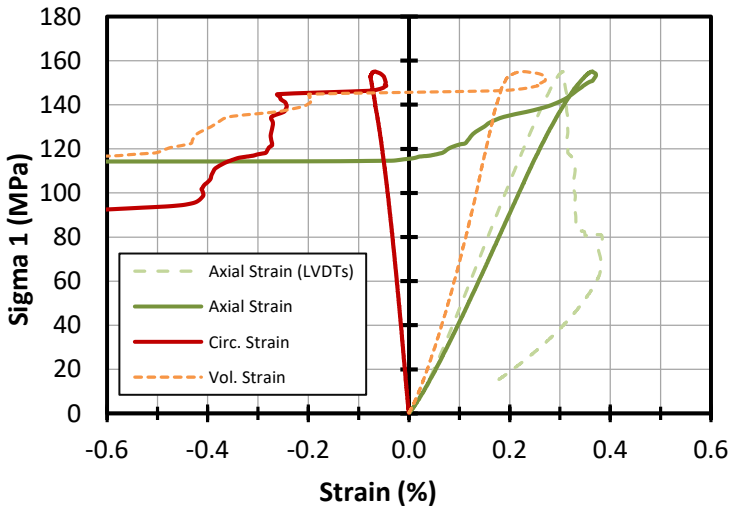
Specimen ID:	BC-81-2-71.20-U	**Moisture Condition:**	dry
Depth (m):	71.20	**Test Completed on:**	14-Feb-20
Length (mm):	104.98	**Load Control:**	axial displ.
Diameter (mm):	47.36	**Loading Rate (mm/s):**	0.0007

Test Results:

Peak Strength (MPa)	**155.0**

	mechanical	*electrical*
Axial Strain at Peak (%)	0.305	0.364
Maximum Volumetric Strain (%)	nd	0.271
Young's Modulus, E (GPa)	57.8	50.1
Poisson's Ratio, v	0.13	0.23

Stress - Strain Curves



Failure Description:

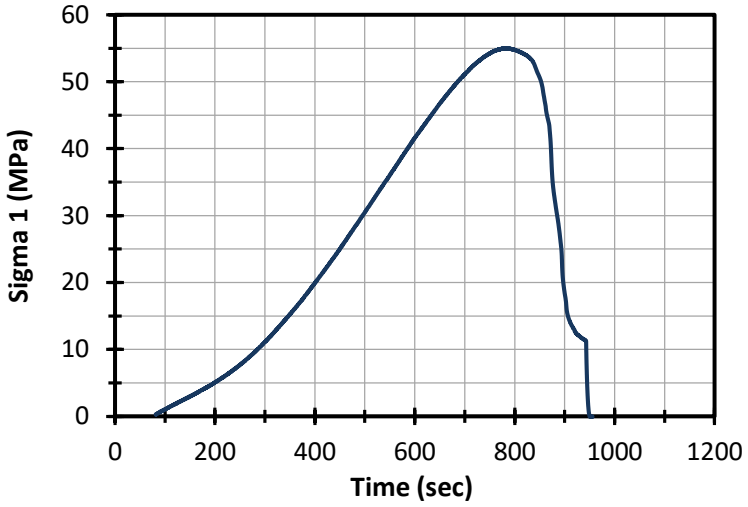
-axial splitting

Notes:

- Testing completed in accordance with ASTM D7012-14
- Elastic properties estimated over the range of 45-55% of peak strength

Uniaxial Compression Strength Test: BC-81-2-75.87-U

Axial Stress - Time



Test and Specimen Data:

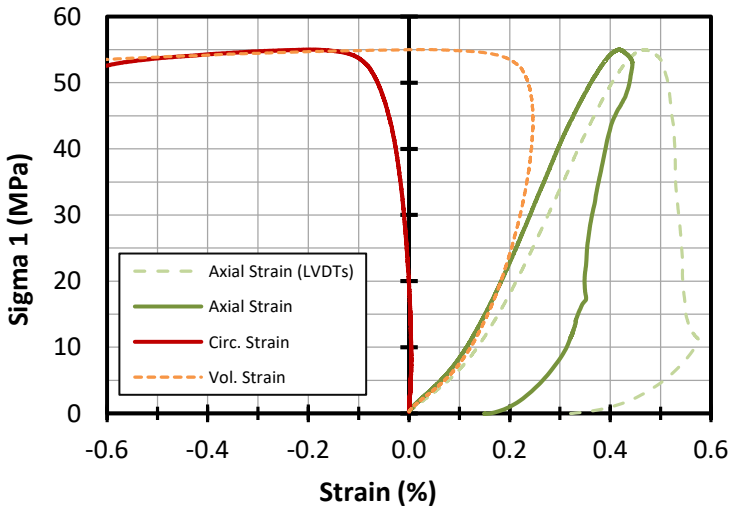
Specimen ID:	BC-81-2-75.87-U	**Moisture Condition:**	dry
Depth (m):	75.87	**Test Completed on:**	14-Feb-20
Length (mm):	104.97	**Load Control:**	axial displ.
Diameter (mm):	47.34	**Loading Rate (mm/s):**	0.0007

Test Results:

Peak Strength (MPa)	**55.0**

	mechanical	*electrical*
Axial Strain at Peak (%)	0.469	0.418
Maximum Volumetric Strain (%)	nd	0.247
Young's Modulus, E (GPa)	16.4	17.9
Poisson's Ratio, v	nd	0.19

Stress - Strain Curves



Failure Description:

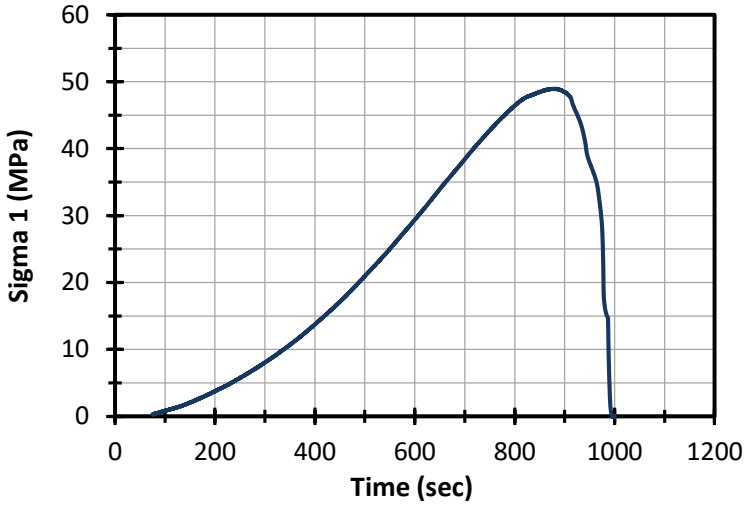
-undulating shear, FA = 60°

Notes:

- Testing completed in accordance with ASTM D7012-14
- Elastic properties estimated over the range of 45-55% of peak strength
-"nd" = could not be determined

Uniaxial Compression Strength Test: BC-81-2-76.12-U

Axial Stress - Time



Test and Specimen Data:

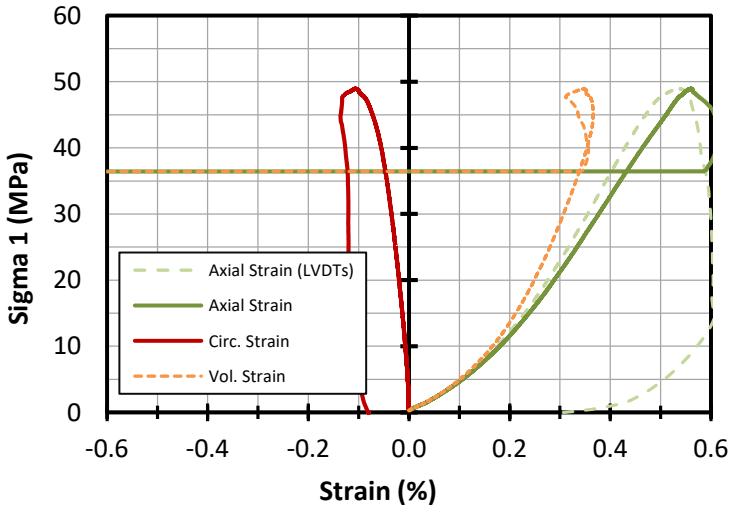
Specimen ID:	BC-81-2-76.12-U	**Moisture Condition:**	dry
Depth (m):	76.12	**Test Completed on:**	14-Feb-20
Length (mm):	104.95	**Load Control:**	axial displ.
Diameter (mm):	47.37	**Loading Rate (mm/s):**	0.0007

Test Results:

Peak Strength (MPa)	**48.9**

	mechanical	*electrical*
Axial Strain at Peak (%)	0.539	0.562
Maximum Volumetric Strain (%)	0.369	0.366
Young's Modulus, E (GPa)	12.6	11.3
Poisson's Ratio, v	0.09	0.17

Stress - Strain Curves



Failure Description:

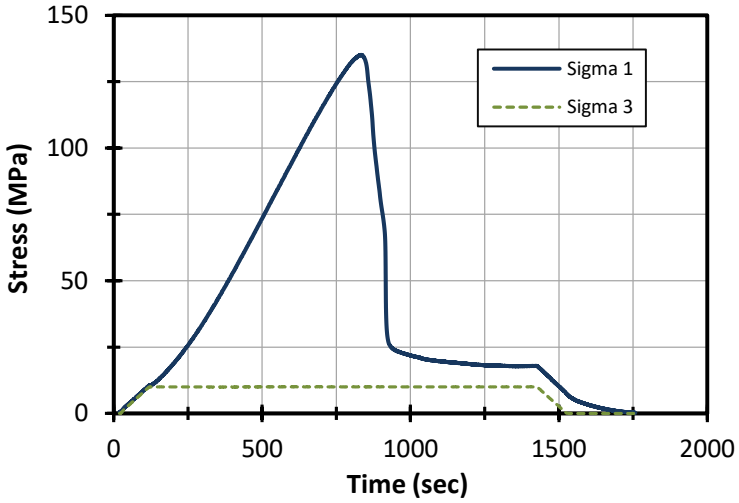
-undulating shear, FA = 65°

Notes:

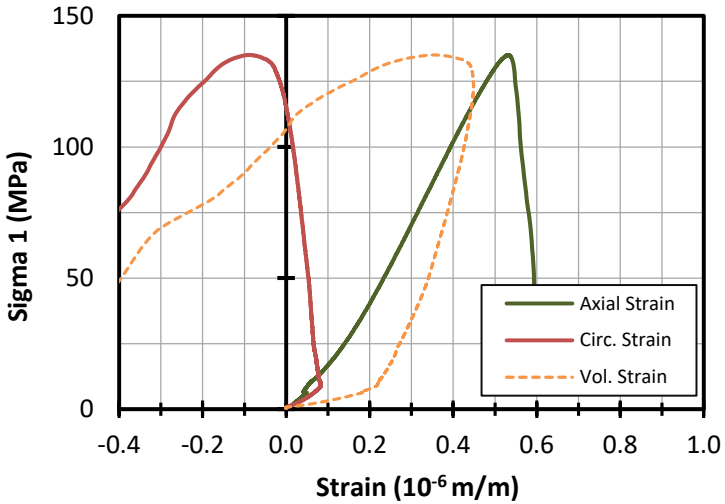
- Testing completed in accordance with ASTM D7012-14
- Elastic properties estimated over the range of 45-55% of peak strength

Triaxial Compression Strength Test: BC-81-2-76.23-T

Stress - Time



Stress - Strain Curves



Test and Specimen Data:

Specimen ID:	**BC-81-2-76.23-T**	**Moisture Condition:**	dry
Rock Type:	sandstone	**Test Completed on:**	12-Mar-20
Length (mm):	104.94	**Load Control:**	axial
Diameter (mm):	47.34	**Loading Rate (mm/s):**	0.0007

Confinement (MPa) | **10.0**

Test Results:

Peak Strength (MPa)	135.1
Axial Strain at Peak (%)	0.533
Maximum Volumetric Strain (%)	0.449
Young's Modulus, E (GPa)	31.4
Poisson's Ratio	0.22

Failure Description:

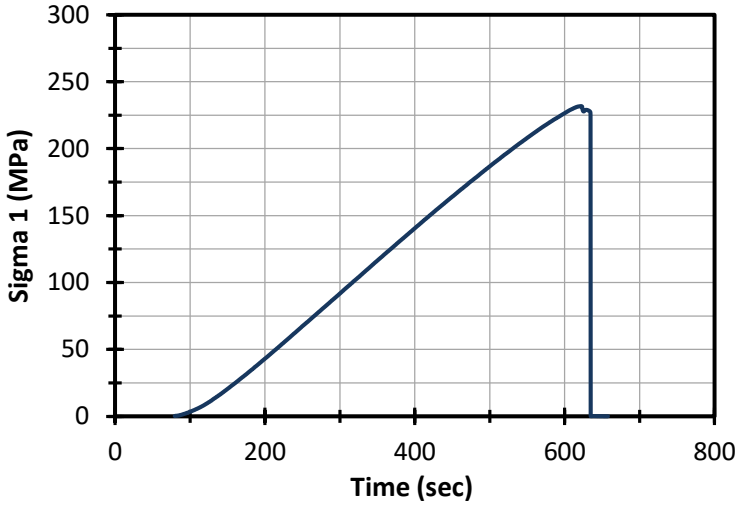
- undulating shear, FA = 63°

Notes:

- Testing completed in accordance with ASTM D7012-14
- Elastic properties estimated over the range of 45-55% of peak strength

Uniaxial Compression Strength Test: BC-81-2-86.74-U

Axial Stress - Time



Test and Specimen Data:

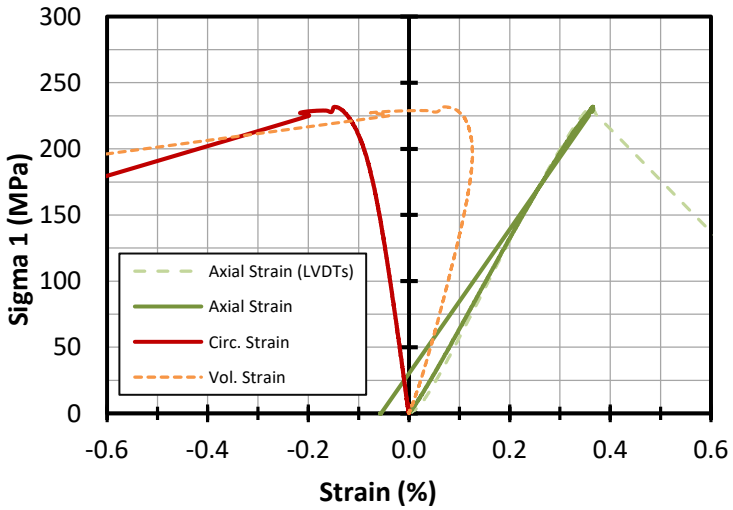
Specimen ID:	BC-81-2-86.74-U	**Moisture Condition:**	dry
Depth (m):	86.74	**Test Completed on:**	14-Feb-20
Length (mm):	105.00	**Load Control:**	axial displ.
Diameter (mm):	47.35	**Loading Rate (mm/s):**	0.0007

Test Results:

Peak Strength (MPa)	**231.7**

	mechanical	*electrical*
Axial Strain at Peak (%)	0.362	0.365
Maximum Volumetric Strain (%)	0.223	0.126
Young's Modulus, E (GPa)	73.4	68.3
Poisson's Ratio, v	0.13	0.28

Stress - Strain Curves



Failure Description:

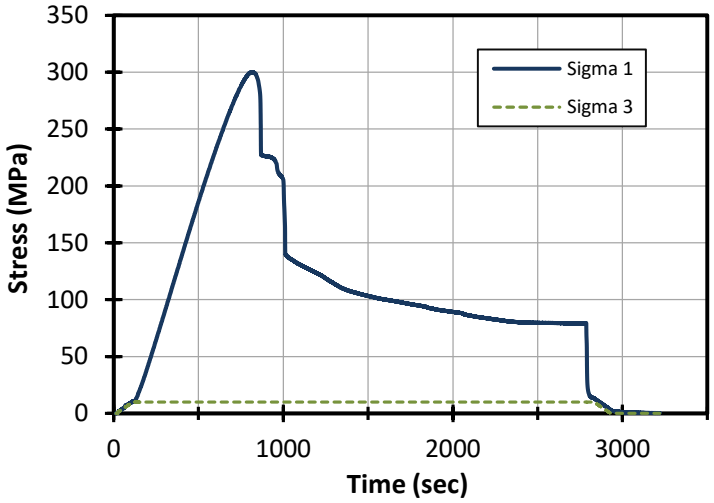
-massive shear, combination of axial splitting and planar shear (FA = 60°)

Notes:

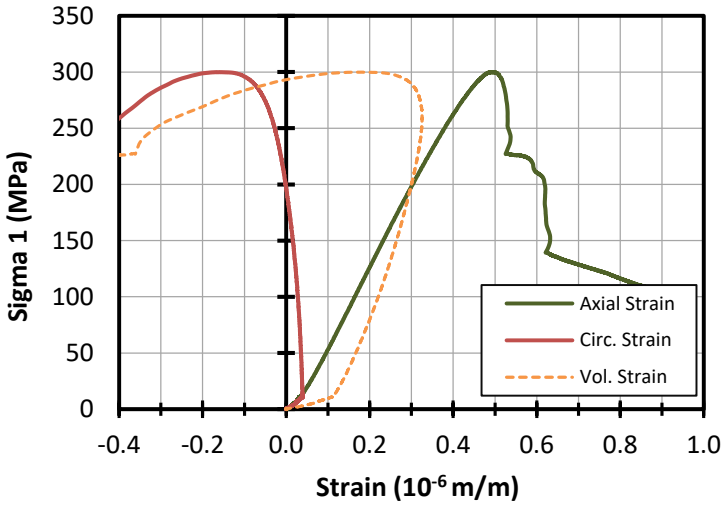
- Testing completed in accordance with ASTM D7012-14
- Elastic properties estimated over the range of 45-55% of peak strength

Triaxial Compression Strength Test: BC-81-2-86.85-T

Stress - Time



Stress - Strain Curves



Test and Specimen Data:

Specimen ID:	**BC-81-2-86.85-T**	**Moisture Condition:**	dry
Rock Type:	sandstone	**Test Completed on:**	13-Mar-20
Length (mm):	105.01	**Load Control:**	axial
Diameter (mm):	47.35	**Loading Rate (mm/s):**	0.0007

Confinement (MPa) | **10.0**

Test Results:

Peak Strength (MPa)	299.9
Axial Strain at Peak (%)	0.494
Maximum Volumetric Strain (%)	0.326
Young's Modulus, E (GPa)	72.9
Poisson's Ratio	0.21

Failure Description:

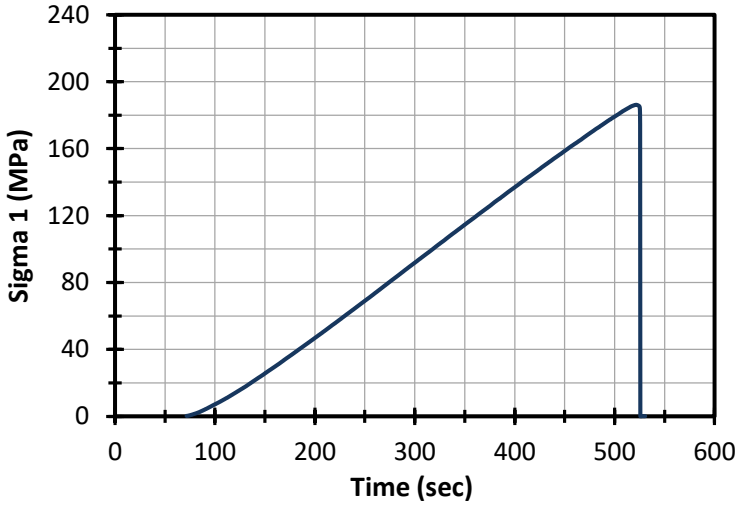
- planar shear, FA = 62°

Notes:

- Testing completed in accordance with ASTM D7012-14
- Elastic properties estimated over the range of 45-55% of peak strength

Uniaxial Compression Strength Test: BC-81-2-86.96-U

Axial Stress - Time



Test and Specimen Data:

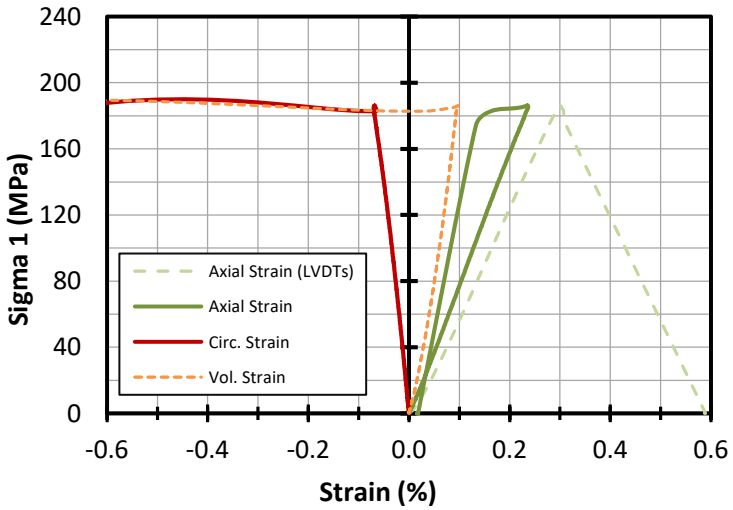
Specimen ID:	BC-81-2-86.96-U	**Moisture Condition:**	dry
Depth (m):	86.96	**Test Completed on:**	14-Feb-20
Length (mm):	104.99	**Load Control:**	axial displ.
Diameter (mm):	47.35	**Loading Rate (mm/s):**	0.0007

Test Results:

Peak Strength (MPa)	**186.2**

	mechanical	*electrical*
Axial Strain at Peak (%)	0.300	0.235
Maximum Volumetric Strain (%)	0.241	0.098
Young's Modulus, E (GPa)	68.1	82.3
Poisson's Ratio, v	0.08	0.30

Stress - Strain Curves



Failure Description:

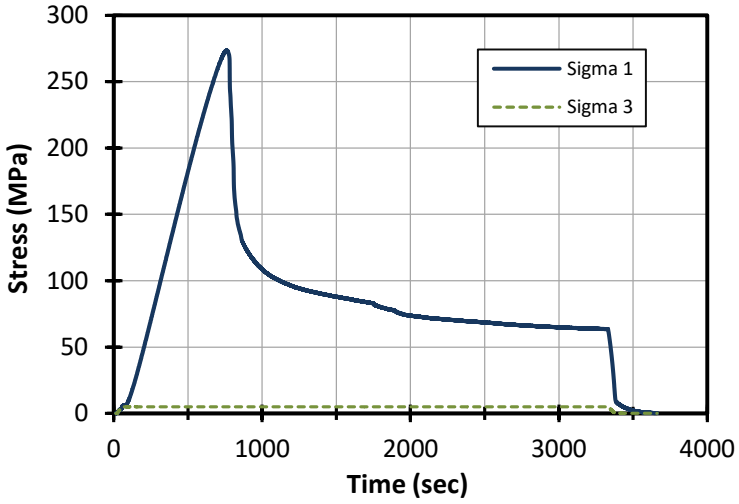
-axial splitting

Notes:

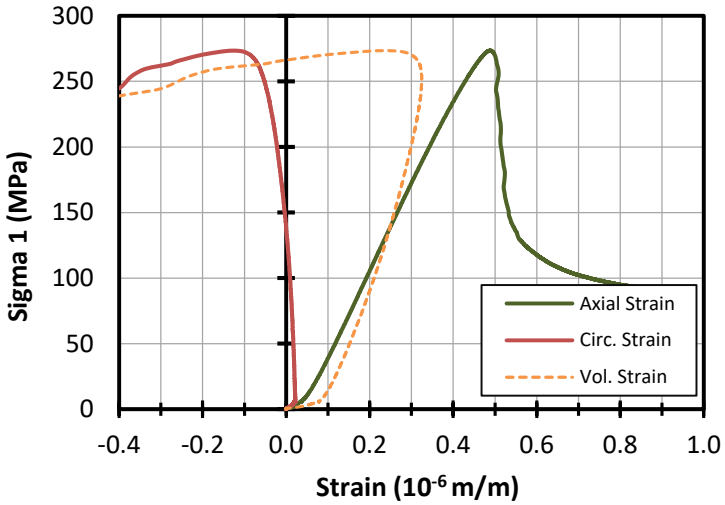
- Testing completed in accordance with ASTM D7012-14
- Elastic properties estimated over the range of 45-55% of peak strength

Triaxial Compression Strength Test: BC-81-2-87.07-T

Stress - Time



Stress - Strain Curves



Test and Specimen Data:

Specimen ID:	**BC-81-2-87.07-T**	**Moisture Condition:**	dry
Rock Type:	sandstone	**Test Completed on:**	13-Mar-20
Length (mm):	105.01	**Load Control:**	axial
Diameter (mm):	47.36	**Loading Rate (mm/s):**	0.0007

Confinement (MPa)	**5.0**

Test Results:

Peak Strength (MPa)	273.4
Axial Strain at Peak (%)	0.489
Maximum Volumetric Strain (%)	0.325
Young's Modulus, E (GPa)	67.3
Poisson's Ratio	0.19

Failure Description:

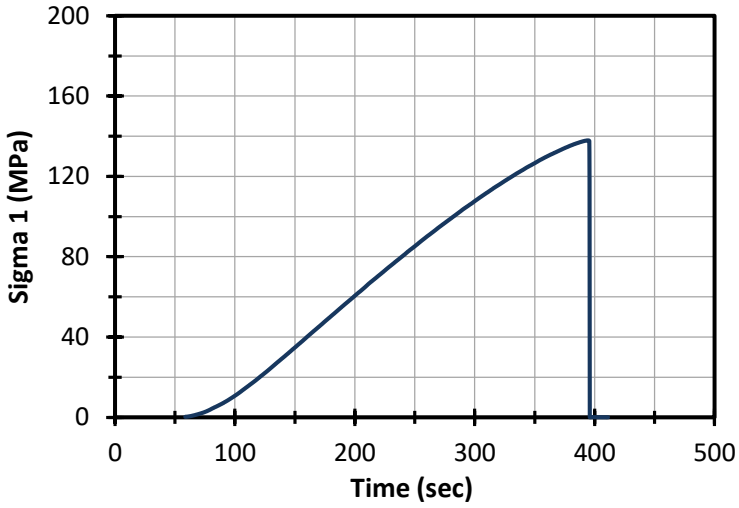
- conical shear

Notes:

- Testing completed in accordance with ASTM D7012-14
- Elastic properties estimated over the range of 45-55% of peak strength

Uniaxial Compression Strength Test: BC-81-2-93.92-U

Axial Stress - Time



Test and Specimen Data:

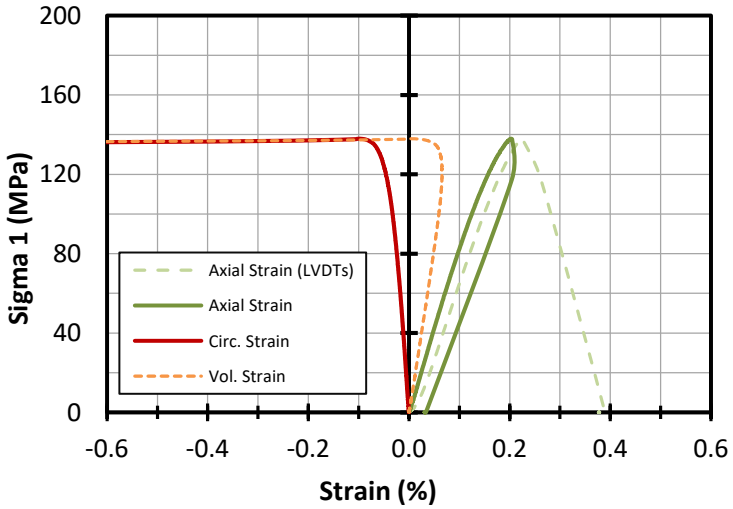
Specimen ID:	BC-81-2-93.92-U	**Moisture Condition:**	dry
Depth (m):	93.92	**Test Completed on:**	14-Feb-20
Length (mm):	104.99	**Load Control:**	axial displ.
Diameter (mm):	47.28	**Loading Rate (mm/s):**	0.0007

Test Results:

Peak Strength (MPa)	**137.9**

	mechanical	*electrical*
Axial Strain at Peak (%)	0.224	0.204
Maximum Volumetric Strain (%)	0.138	0.066
Young's Modulus, E (GPa)	75.1	78.9
Poisson's Ratio, v	0.12	0.27

Stress - Strain Curves



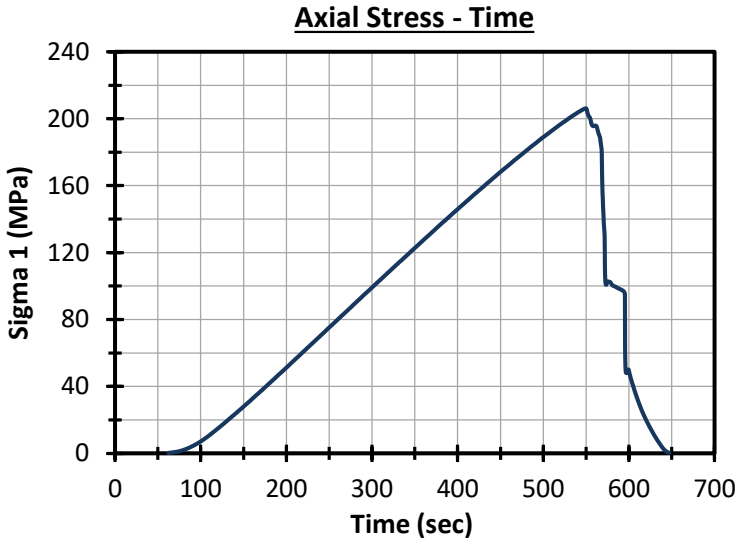
Failure Description:

- wedge failure (55°), from top-middle

Notes:

- Testing completed in accordance with ASTM D7012-14
- Elastic properties estimated over the range of 45-55% of peak strength

Uniaxial Compression Strength Test: BC-81-2-99.17-U



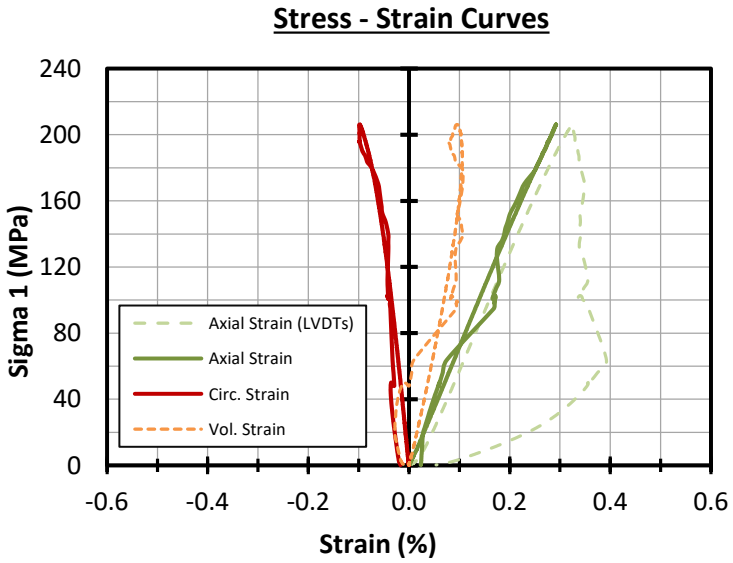
Test and Specimen Data:

Specimen ID:	BC-81-2-99.17-U	**Moisture Condition:**	dry
Depth (m):	99.17	**Test Completed on:**	14-Feb-20
Length (mm):	105.00	**Load Control:**	axial displ.
Diameter (mm):	47.34	**Loading Rate (mm/s):**	0.0007

Test Results:

Peak Strength (MPa)	**206.2**

	mechanical	*electrical*
Axial Strain at Peak (%)	0.325	0.292
Maximum Volumetric Strain (%)	0.226	0.106
Young's Modulus, E (GPa)	71.2	73.3
Poisson's Ratio, v	0.11	0.28



Failure Description:

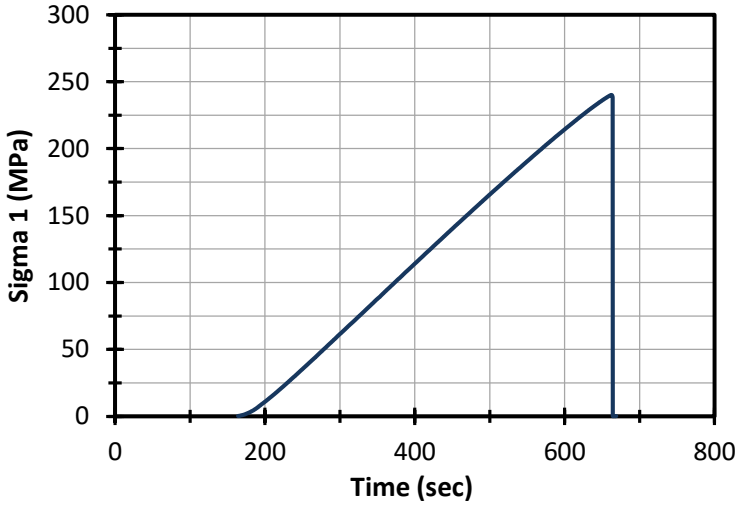
- axial splitting

Notes:

- Testing completed in accordance with ASTM D7012-14
- Elastic properties estimated over the range of 45-55% of peak strength

Uniaxial Compression Strength Test: BC-81-2-99.28-U

Axial Stress - Time



Test and Specimen Data:

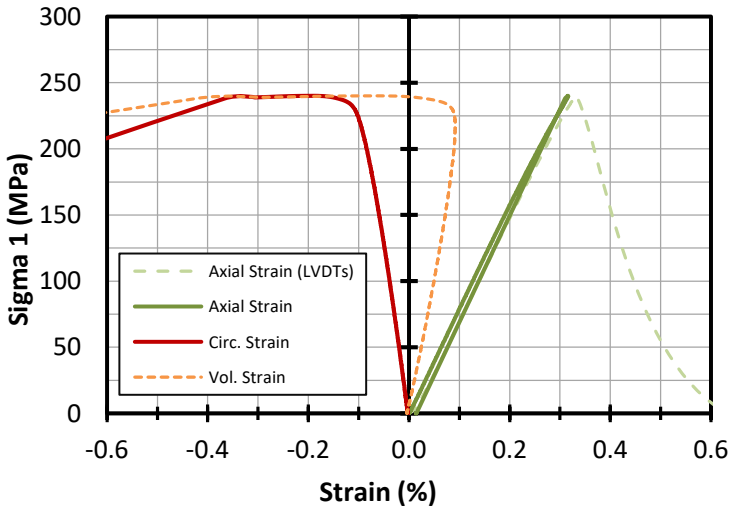
Specimen ID:	BC-81-2-99.28-U	**Moisture Condition:**	dry
Depth (m):	99.28	**Test Completed on:**	14-Feb-20
Length (mm):	105.00	**Load Control:**	axial displ.
Diameter (mm):	47.31	**Loading Rate (mm/s):**	0.0007

Test Results:

Peak Strength (MPa)	**240.1**

	mechanical	*electrical*
Axial Strain at Peak (%)	0.332	0.316
Maximum Volumetric Strain (%)	0.256	0.092
Young's Modulus, E (GPa)	78.2	78.4
Poisson's Ratio, v	0.08	0.32

Stress - Strain Curves



Failure Description:

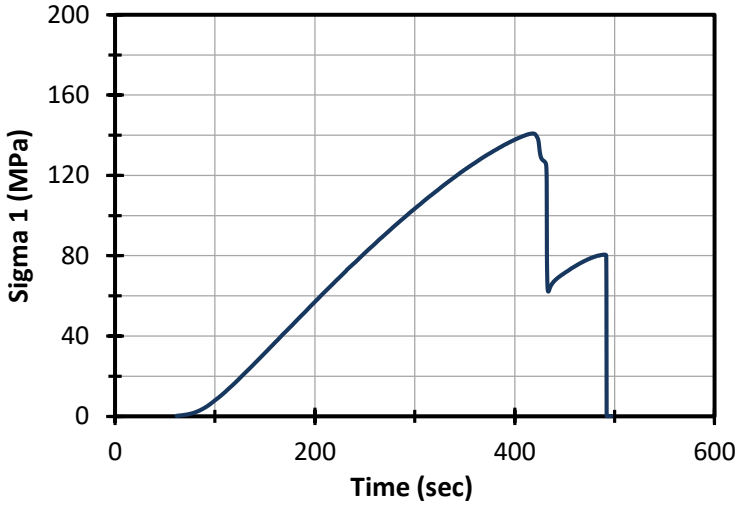
- massive planar shear, FA = 60°

Notes:

- Testing completed in accordance with ASTM D7012-14
- Elastic properties estimated over the range of 45-55% of peak strength

Uniaxial Compression Strength Test: BC-81-2-109.01-U

Axial Stress - Time



Test and Specimen Data:

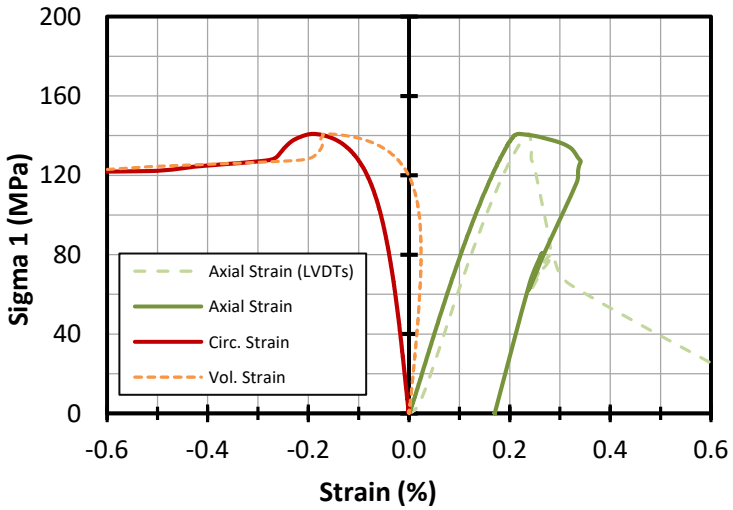
Specimen ID:	BC-81-2-109.01-U	**Moisture Condition:**	dry
Depth (m):	109.01	**Test Completed on:**	17-Feb-20
Length (mm):	105.00	**Load Control:**	axial displ.
Diameter (mm):	47.23	**Loading Rate (mm/s):**	0.0007

Test Results:

Peak Strength (MPa)	**140.9**

	mechanical	*electrical*
Axial Strain at Peak (%)	0.237	0.218
Maximum Volumetric Strain (%)	0.129	0.024
Young's Modulus, E (GPa)	72.6	73.6
Poisson's Ratio, v	0.15	0.45

Stress - Strain Curves



Failure Description:

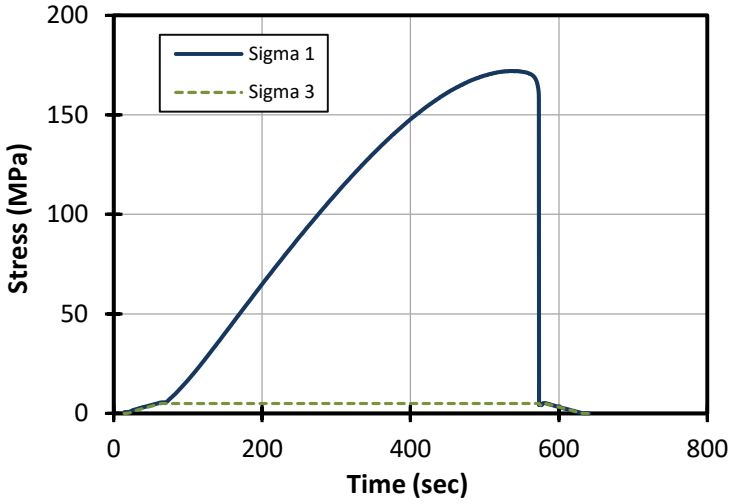
- planar shear, FA = 64°

Notes:

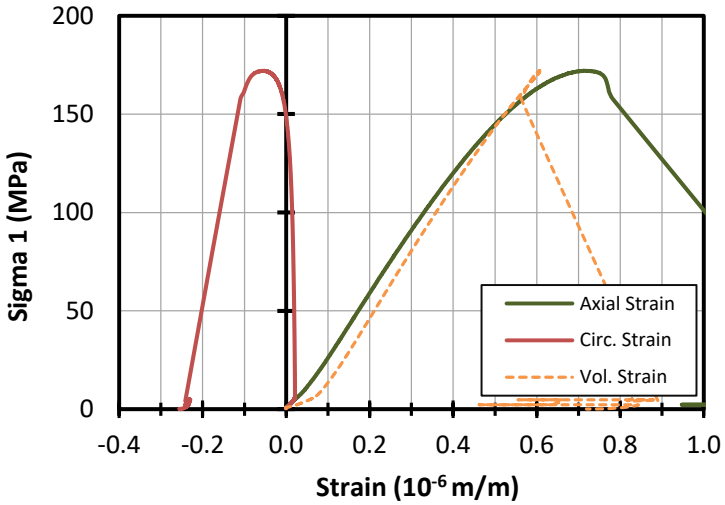
- Testing completed in accordance with ASTM D7012-14
- Elastic properties estimated over the range of 45-55% of peak strength

Triaxial Compression Strength Test: BC-81-2-109.12-T

Stress - Time



Stress - Strain Curves



Test and Specimen Data:

Specimen ID:	**BC-81-2-109.12-T**	**Moisture Condition:**	dry
Rock Type:	sandstone	**Test Completed on:**	13-Mar-20
Length (mm):	47.24	**Load Control:**	axial
Diameter (mm):	105.00	**Loading Rate (mm/s):**	0.0007

Confinement (MPa) | **5.0**

Test Results:

Peak Strength (MPa)	172.0
Axial Strain at Peak (%)	0.715
Maximum Volumetric Strain (%)	0.608
Young's Modulus, E (GPa)	31.1
Poisson's Ratio	0.03

Failure Description:

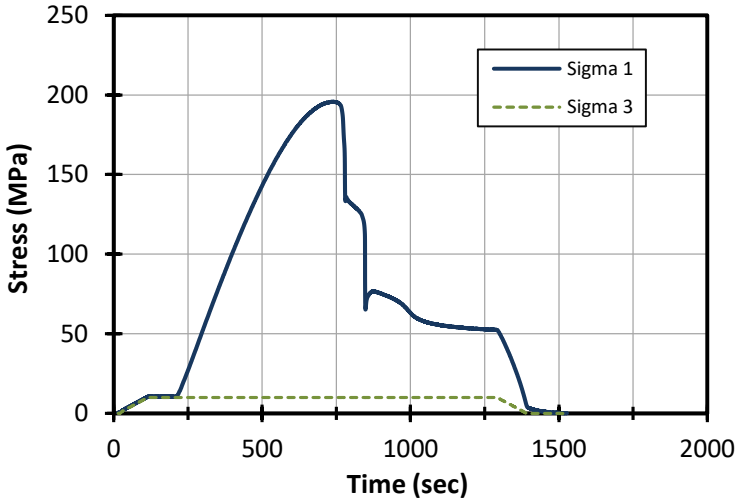
- planar shear, FA = 65°

Notes:

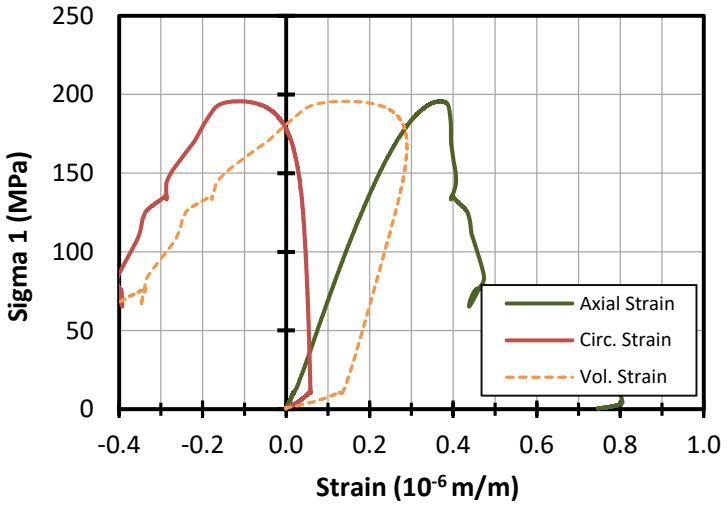
- Testing completed in accordance with ASTM D7012-14
- Elastic properties estimated over the range of 45-55% of peak strength

Triaxial Compression Strength Test: BC-81-2-109.23-T

Stress - Time



Stress - Strain Curves



Test and Specimen Data:

Specimen ID:	**BC-81-2-109.23-T**	**Moisture Condition:**	dry
Rock Type:		**Test Completed on:**	13-Mar-20
Length (mm):	104.99	**Load Control:**	axial
Diameter (mm):	47.24	**Loading Rate (mm/s):**	0.0007

Confinement (MPa) **10.0**

Test Results:

Peak Strength (MPa)	195.7
Axial Strain at Peak (%)	0.372
Maximum Volumetric Strain (%)	0.289
Young's Modulus, E (GPa)	69.5
Poisson's Ratio	0.14

Failure Description:

- planar shear, FA = 60°

Notes:

- Testing completed in accordance with ASTM D7012-14
- Elastic properties estimated over the range of 45-55% of peak strength