Tet & cube unit tests

Example	# nodes, # tets, # faces	h (s)	density (kg/m^3) E (Pa), nu	dHat (m)	friction coefficient, epsilon_v (m/s), # friction iters	Newton tol (m/s)	# contact avg (max)	machine	memory (MB)	per time step t (s), # iters
C-box	285, 812, 510	0.04	1000 1e5, 0.4	1e-5l	N/A	1E-02l	41 (381)	4-core 2.9 GHz Intel Core i7, 16 GB memory	80	0.2, 12.8
Tet-tet	8, 2, 8	0.025	1000 1e5, 0.4	1e-3l	N/A	1E-02l	0 (6)	4-core 2.9 GHz Intel Core i7, 16 GB memory	70	1.4e-3, 2.3
Cube stack	40, 30, 60	0.025	1000 1e5, 0.4	1e-3l	N/A	1E-02l	8 (69)	4-core 2.9 GHz Intel Core i7, 16 GB memory	76	6e-3, 3.25
Tet corner	28, 19, 40	0.025	1000 1e5, 0.4	1e-6l	N/A	1E-02l	5 (21)	4-core 2.9 GHz Intel Core i7, 16 GB memory	70	2e-3, 3.9
Erleben's Spikes	5, 2, 6	0.01	1000 1e5, 0.4	1e-3l	N/A	1E-02l	0 (4)	4-core 3.0 GHz Intel Xeon E-2690v2, 32 GB memory	11	9.4e-4, 2.05
Erleben's Spike and Wedge	5, 2, 6	0.01	1000 1e5, 0.4	1e-3l	N/A	1E-02l	0 (3)	4-core 3.0 GHz Intel Xeon E-2690v2, 32 GB memory	11	1.0e-3, 2.01
Erleben's Wedges	6, 3, 8	0.01	1000 1e5, 0.4	1e-3l	N/A	1E-02l	0 (19)	4-core 3.0 GHz Intel Xeon E-2690v2, 32 GB memory	11	8.1e-4, 2.06
Erleben's Spike in a Hole	5, 2, 6	0.01	1000 1e5, 0.4	1e-3l	N/A	1E-02l	0 (5)	4-core 3.0 GHz Intel Xeon E-2690v2, 32 GB memory	11	1.0e-3, 2.10
Erleben's Spike in a Crack	5, 2, 6	0.01	1000 1e5, 0.4	1e-3l	N/A	1E-02l	0 (2)	4-core 3.0 GHz Intel Xeon E-2690v2, 32 GB memory	11	7.7e-4, 2.01
Erleben's Wedge in a Crack	6, 3, 8	0.01	1000 1e5, 0.4	1e-3l	N/A	1E-02l	0 (3)	4-core 3.0 GHz Intel Xeon E-2690v2, 32 GB memory	11	3.0e-3, 2.01
Erleben's Sliding Spike	5, 2, 6	0.01	1000 1e5, 0.4	1e-3l	N/A	1E-02l	0 (1)	4-core 3.0 GHz Intel Xeon E-2690v2, 32 GB memory	11	9.5e-4, 2.01
Erleben's Sliding Wedge	6, 3, 8	0.01	1000 1e5, 0.4	1e-3l	N/A	1E-02l	0 (1)	4-core 3.0 GHz Intel Xeon E-2690v2, 32 GB memory	11	9.6e-4, 2.00
Erleben's Cliff Edges	8, 6, 12	0.01	1000 1e5, 0.4	1e-3l	N/A	1E-02l	7 (28)	4-core 3.0 GHz Intel Xeon E-2690v2, 32 GB memory	11	1.7e-3, 1.97
Erleben's Internal Edges	8, 6, 2	0.01	1000 1e5, 0.4	1e-3l	N/A	1E-02l	18 (28)	4-core 3.0 GHz Intel Xeon E-2690v2, 32 GB memory	11	1.3e-3, 2.03

Co-dimensional obstacles unit tests

Example	# nodes, # tets, # faces	h (s)	density (kg/m^3) E (Pa), nu	dHat (m)	friction coefficient, epsilon_v (m/s), # friction iters	Newton tol (m/s)	# contact avg (max)	machine	memory (MB)	per time step t (s), # iters
Ball on points	7K, 28K, 10K	0.04	1000, 1e4, 0.4	1e-3l	N/A	1E-02l	126 (182)	4-core 2.9 GHz Intel Core i7, 16 GB memory	229	2.8, 6.6
Ball on segments	7K, 28K, 10K	0.04	1000, 1e4, 0.4	1e-3l	N/A	1E-02l	439 (706)	4-core 2.9 GHz Intel Core i7, 16 GB memory	196	4.4, 11.3
Ball on squares	7K, 28K, 10K	0.04	1000, 1e4, 0.4	1e-3l	N/A	1E-02l	908 (1K)	4-core 2.9 GHz Intel Core i7, 16 GB memory	239	5.5, 13.4
Octocat on points	7K, 21K, 9K	0.04	1000, 1e4, 0.4	1e-3l	N/A	1E-02l	193 (846)	4-core 2.9 GHz Intel Core i7, 16 GB memory	272	5.0, 11.1
Octocat on segments	7K, 21K, 9K	0.04	1000, 1e4, 0.4	1e-3l	N/A	1E-02l	354 (1K)	4-core 2.9 GHz Intel Core i7, 16 GB memory	231	4.5, 10.4
Octocat on squares	7K, 21K, 9K	0.04	1000, 1e4, 0.4	1e-3l	N/A	1E-02l	808 (1.2K)	4-core 2.9 GHz Intel Core i7, 16 GB memory	241	5.0, 11.4
Mat on points	3K, 9K, 6K	0.04	1000, 1e4, 0.4	1e-3l	N/A	1E-02l	112 (250)	4-core 2.9 GHz Intel Core i7, 16 GB memory	159	0.64, 2.9
Mat on segments	3K, 9K, 6K	0.04	1000, 1e4, 0.4	1e-3l	N/A	1E-02l	326 (419)	4-core 2.9 GHz Intel Core i7, 16 GB memory	163	0.5, 2.5
Mat on squares	3K, 9K, 6K	0.04	1000, 1e4, 0.4	1e-3l	N/A	1E-02l	468 (780)	4-core 2.9 GHz Intel Core i7, 16 GB memory	141	1.5, 5.0

Stress tests and general examples - 1

Example	# nodes, # tets, # faces	h (s)	density (kg/m^3) E (Pa), nu	dHat (m)	friction coefficient, epsilon_v (m/s), # friction iters	Newton tol (m/s)	# contact avg (max)	machine	memory (MB)	per time step t (s), # iters
Mat on knives	3.2K, 9.1K, 6.4K	0.04	1000 2e4, 0.4	1e-3l	N/A	1E-02l	291 (472)	4-core 2.9 GHz Intel Core i7, 16 GB memory	147	1.4, 5.5
5 chains	1K, 2.5K, 2K	0.04	1000 1e5, 0.4	1e-3l	N/A	1E-02l	185 (260)	4-core 2.9 GHz Intel Core i7, 16 GB memory	97	0.2, 4.3
35 chains	7K, 17K, 14K	0.04	1000 1e7, 0.4	1e-3l	N/A	1E-02l	1.7K (2.5K)	4-core 2.9 GHz Intel Core i7, 16 GB memory	191	1.1, 2.6
100 chains	20K, 49K, 40K	0.04	500, 1e7, 0.4	1e-3l	N/A	1E-02l	40K (53K)	4-core 2.9 GHz Intel Core i7, 16 GB memory	450	4.0, 2.4
Ball on mat	5K, 16K, 9K	0.01	2000, 1e8, 0.4 (ball) 1000, 1e6, 0.4 (mat)	1e-3l	N/A	1E-02l	327 (687)	4-core 2.9 GHz Intel Core i7, 16 GB memory	173	2.0 6.9
Cube on small cube	16, 12, 24	0.025	1e4, 1e8, 0.4 (large) 1000, 1e6, 0.4 (small)	1e-3l	N/A	1E-02l	14 (18)	4-core 2.9 GHz Intel Core i7, 16 GB memory	57	2e-3, 4.2
Dolphin funnel	8K, 36K, 10K	0.04	1000 1e4, 0.4	1e-3l	N/A	1E-02l	7K (31K)	4-core 2.9 GHz Intel Core i7, 16 GB memory	357	27.9, 39.7
Dolphin funnel (FCR)	8K, 36K, 10K	0.04	1000 1e4, 0.4	1e-3l	N/A	1E-02l	7K (35K)	4-core 2.9 GHz Intel Core i7, 16 GB memory	283	81.3, 129.7
Pin-cushion compress	9K, 28K, 10K	0.04	1000 1e4, 0.4	1e-3l	N/A	1E-02l	317 (496)	4-core 2.9 GHz Intel Core i7, 16 GB memory	233	3.7, 9.5
Golf ball (NM)	29K, 118K, 38K	2E-05	1150, 1e7, 0.45	1e-3l	N/A	1E-02l	1K (4K)	4-core 2.9 GHz Intel Core i7, 16 GB memory	861	12.1, 9.3
Bunny matrix	57K, 196K, 92K	0.04	1000 5e6, 0.4	1e-3l	N/A	1E-02l	5.7K (7.0K)	4-core 3.6 GHz Intel Core i7, 32 GB memory	1338	123.0, 77.1
tunneling test 10 m/s	2.6K, 6.9K, 4K	0.02	1000, 1e6, 0.4	1e-3l	N/A	1E-02l	1 (62)	4-core 2.9 GHz Intel Core i7, 16 GB memory	201	4.7, 12.1
tunneling test 100 m/s	2.6K, 6.9K, 4K	0.02	1000, 1e6, 0.4	1e-3l	N/A	1E-02l	4 (297)	4-core 2.9 GHz Intel Core i7, 16 GB memory	235	6.2, 14.4
tunneling test 1000 m/s	2.6K, 6.9K, 4K	0.02	1000, 1e6, 0.4	1e-3l	N/A	1E-02l	10 (876)	4-core 2.9 GHz Intel Core i7, 16 GB memory	306	8.2, 19.5

Stress tests and general examples - 2

Example	# nodes, # tets, # faces	h (s)	density (kg/m^3) E (Pa), nu	dHat (m)	friction coefficient, epsilon_v (m/s), # friction iters	Newton tol (m/s)	# contact avg (max)	machine	memory (MB)	per time step t (s), # iters
Mat twist (100s)	45K, 133K, 90K	0.04	1000 2e4, 0.4	1e-3l	N/A	1E-02l	264K (439K)	8-core 3.0 GHz Intel Xeon, 32GB memory	4546	776.2, 34.5
Rods twist (100s)	53K, 202K, 80K	0.025	1000 1e4, 0.4	1e-3l	N/A	1E-02l	243K (498K)	8-core 3.0 GHz Intel Xeon, 32GB memory	2638	141.5 ,14.1
Trash compactor - octocat	6K, 21K, 9K	0.01	1000 1e4, 0.4	1e-3l	N/A	1E-02l	793 (34K)	8-core 3.0 GHz Intel Xeon, 32GB memory	447	12.8, 16.9
Trash compactor - ball & mat & bunny	15K, 56K, 22K	0.01	1000 1e4, 0.4	1e-3l	N/A	1E-02l	6K (132K)	8-core 3.0 GHz Intel Xeon, 32GB memory	638	61.9, 29.4
Squeeze out	45K, 181K, 60K	0.01	1000, 5e4, 0.4	1e-3l	N/A	1E-02l	37K (277K)	8-core 3.0 GHz Intel Xeon, 32GB memory	1700	252, 42.5
Heavy ball hit	47K, 187K, 62K	0.01	1000, 5e4, 0.4	1e-3l	N/A	1E-02l	13K (59K)	8-core 3.0 GHz Intel Xeon, 32GB memory	1498	263.9, 44.2

Scalability Tests

Example	# nodes, # tets, # faces	h (s)	density (kg/m^3) E (Pa), nu	dHat (m)	friction coefficient, epsilon_v (m/s), # friction iters	Newton tol (m/s)	# contact avg (max)	machine	memory (MB)	per time step t (s), # iters
Armadillo13K twist	13K, 55K, 17K	0.025	1000, 5e3, 0.4	1e-3l	N/A	1E-02l	832 (2.7K)	4-core 3.6 GHz Intel Core i7, 32 GB memory	453	4.3, 10.6
Armadillo28K twist	28K, 121K, 35K	0.025	1000, 5e3, 0.4	1e-3l	N/A	1E-02l	2.5K (72K)	4-core 3.6 GHz Intel Core i7, 32 GB memory	890	11.8, 10.2
Armadillo54K twist	54K, 227K, 69K	0.025	1000, 5e3, 0.4	1e-3l	N/A	1E-02l	5.5K (17K)	4-core 3.6 GHz Intel Core i7, 32 GB memory	1632	23.7, 10.0
Armadillo122K twist	122K, 548K, 140K	0.025	1000, 5e3, 0.4	1e-3l	N/A	1E-02l	22K (54K)	4-core 3.6 GHz Intel Core i7, 32 GB memory	3744	64.0, 9.8
Armadillo219K twist	219K, 928K, 277K	0.025	1000, 5e3, 0.4	1e-3l	N/A	1E-02l	60.6K (133K)	4-core 3.6 GHz Intel Core i7, 32 GB memory	6547	126.2, 10.0
Mat40x40 twist (10s)	3K, 9K, 6K	0.04	1000, 2e4 0.4	1e-3l	N/A	1E-02l	2K (4.6K)	4-core 3.6 GHz Intel Core i7, 32 GB memory	196	1.3, 7.6
Mat100x100 twist (10s)	20K, 59K, 40K	0.04	1000, 2e4 0.4	1e-3l	N/A	1E-02l	31K (60K)	4-core 3.6 GHz Intel Core i7, 32 GB memory	792	9.6, 7.5
Mat150x150 twist (10s)	45K, 133K, 90K	0.04	1000, 2e4 0.4	1e-3l	N/A	1E-02l	87K (162K)	4-core 3.6 GHz Intel Core i7, 32 GB memory	1815	33.1, 10.9
Mat225x225 twist (10s)	101K, 301K, 202K	0.04	1000, 2e4 0.4	1e-3l	N/A	1E-02l	222K (408K)	4-core 3.6 GHz Intel Core i7, 32 GB memory	3895	107.2, 15.3
Squishy ball (with AMGCL)	688K, 2314K, 1064K	1E-03	1000, 7e4, 0.4	1e-4l	N/A	4E-02l	3.6K (105K)	8-core 3.6 GHz Intel Core i9, 64GB memory	19463	328.3, 12.2

Examples with friction

Example	# nodes, # tets, # faces	h (s)	density (kg/m^3) E (Pa), nu	dHat (m)	friction coefficient, epsilon_v (m/s), # friction iters	Newton tol (m/s)	# contact avg (max)	machine	memory (MB)	per time step t (s), # iters
Ball mesh roller	7K, 28K, 11K	0.01	1000, 1e4, 0.4	1e-3l	0.5, 1e-3l, 1	1E-02l	2.3K (5.6K)	4-core 2.9 GHz Intel Core i7, 16 GB memory	215	63.3, 58.6
Ball segment roller	7K, 28K, 11K	0.01	1000, 1e4, 0.4	1e-3l	0.5, 1e-3l, 1	1E-02l	1.4K (4K)	4-core 2.9 GHz Intel Core i7, 16 GB memory	210	35.6, 51.8
Ball points roller	7K, 28K, 11K	0.01	1000, 1e4, 0.4	1e-3l	1e-3, 1e-3l, 1	1E-02l	305 (1.2K)	4-core 2.9 GHz Intel Core i7, 16 GB memory	210	9.5, 26.9
Hit board house	6K, 15K, 11K	0.025	1000, 1e8, 0.4	1e-4l	1.0, 1e-5l, 2	1E-02l	7K (13K)	4-core 2.9 GHz Intel Core i7, 16 GB memory	186	10.0, 16.6
Stable board house	5K, 15K, 11K	0.025	1000, 1e8, 0.4	1e-3l	0.2, 1e-5l, *	1E-02l	1.3K (1.4K)	4-core 2.9 GHz Intel Core i7, 16 GB memory	205	0.4, 1.2
Unstable board house	5K, 15K, 11K	0.025	1000, 1e8, 0.4	1e-3l	0.1, 1e-5l, *	1E-02l	7K (10K)	4-core 2.9 GHz Intel Core i7, 16 GB memory	299	2.4, 8.9
Stick-slip pen (NM)	630, 2K, 1K	1E-03	1000, 1e5, 0.4	1e-3l	0.35, 1e-6l, 1	1E-04l	0 (16)	4-core 2.9 GHz Intel Core i7, 16 GB memory	71	0.5, 30.8
Mat on board	6K, 18K, 12K	0.025	1000, 1e4, 0.4	1e-3l	0.1, 1e-3l, 1	1E-02l	1.7K (8,2K)	4-core 2.9 GHz Intel Core i7, 16 GB memory	243	7.7, 15.24
Cement Arch	216, 150, 324	0.01	2300, 2e10, 0.2	1E-06	0.5, 1e-5l, *	1E-04l	101 (118)	4-core 3.6 GHz Intel Core i7, 32 GB memory	54	0.05, 5.7
Toy arch fall	216, 150, 324	0.01	1000, 1e6, 0.4	1e-3l	0.2, 1e-5l, *	1E-02l	66 (272)	4-core 3.6 GHz Intel Core i7, 32 GB memory	55	0.15, 17.3
Block on slope 1	8, 6, 24	0.025	1000, 1e9, 0.4	1e-3l	0.5, 1e-5l, *	1E-04l	4 (4)	4-core 3.6 GHz Intel Core i7, 32 GB memory	50	9e-4, 1.27
Block on slope 2	8, 6, 24	0.025	1000, 1e9, 0.4	1e-3l	0.49, 1e-5l, *	1E-04l	4 (4)	4-core 3.6 GHz Intel Core i7, 32 GB memory	51	3e-3, 6.9
Stick-slip Armadillo roller	67K, 386K, 24K	0.025	1000, 5e5, 0.2	1e-3l	0.5, 1e-3l, 2	1E-02l	7.8K (16.2K)	8-core 3.0 GHz Intel Xeon, 32GB memory	3542	1281.4, 113.9
Stick-slip Armadillo roller (FCR)	67K, 386K, 24K	0.025	1000, 5e5, 0.2	1e-3l	0.5, 1e-3l, 1	1E-02l	8K (33K)	4-core 3.6 GHz Intel Core i7, 32 GB memory	3651	346, 66.8
Softer Armadillo roller (FCR)	67K, 386K, 24K	0.025	1000, 1e5, 0.2	1e-3l	0.5, 1e-3l, 1	1E-02l	11K (27K)	8-core 3.0 GHz Intel Xeon, 32GB memory	3646	664,8, 60.3