Supporting Materials

Table S1 Shear strength parameters of municipal solid waste (MSW) and mechanical biological treatment (MBT) waste.

Author	Year	Method	c (kPa) [a)]	φ (°) [b)]	Type / Source / Main research
Landva and Clark	1986	DS [c)]	10–23	24–42	MSW from Canadian landfills
Landva and Clark	1990	DS	0–39	16–41	MSW from Canadian landfills
Singh and Murphy	1990	DS	0	39–53	MSW/ Stability analysis
Grisolia et al.	1995	TCX [d)]	5–30	10–20	MSW/ Stress–strain
Gabr and Valero	1995	DS, TCX	0–28	20–39	MSW/ Geotechnical Properties
Kölsch	1995	DS	55, 67	31.8, 36.1	MBT waste
Edincliler et al.	1996	DS	27	42	MSW/Age
Kavazanjian et al.	1999	DS	–	–	MSW/Fiber content
Mazzucato et al.	1999	DS	22	18	MSW/Reconstituted samples
Powrie and Beaven	1999	DS	0	45.8, 47	MBT waste
Thomas et al.	1999	DS	–	–	MSW/Plastic content
Ziehmann	1999	DS	15	35–38	MBT waste in Germany
Pelkey et al.	2001	DS	0–50	26–35	MSW
Caicedo et al.	2002	DS	67	23	MSW from Bogota landfills
Kuehle-Weidemeier and Doedens	2004	DS	11–62	32–38	MBT waste in Germany

De Lamare Neto	2004	–	–	–	MBT/Reinforced material
Zekkos	2005	DS, TCX	–	–	MSW/Loading rate
Feng	2005	TCX	7–30	14–19	MSW/ Strength parameter
Vilar and Carvalho	2005	TCX	20–71	22–33	MSW/ Shear strength
Harris et al.	2006	DS, TCX	9–14	20–29	MSW/Stress–strain, age
Mahler and De Lamare Neto	2006	DS	–	–	MBT waste in Brazil/Fiber content
Zhan et al.	2008	TCX	0–23.3	9.9–26	MSW/Age
Bray et al.	2009	DS, TCX	0–70	15–42	MSW from California landfills
Hossain and Haque	2009	TCX	2.4–24.5	19–33.1	MSW/ Daily cover soils
Reddy et al.	2009	TCX	32	12	MSW/Stress–strain
Zekkos et al.	2010	DS	21–23	2–33	MSW/Composition, confining stress
Cho et al.	2011	DS	2–36	15–38	MSW/Organic content
Reddy et al.	2011	TCX	21–57	1–9	MSW/biodegradation
Fernando	2011	DS	70, 27	31, 41	MBT/Shear strength
Bareither et al.	2012	DS	20	37	MSW/ Composition, decomposition
Bhandari and Powrie	2013	TCX	–	38, 57	MBT waste in England/Stress–strain, reinforced material
Pimolthai and Wagner	2014	DS	–	–	MBT waste in Germany/Stress–strain, plastic content
Shariatmadari et al.	2014	TCX	11–36	10–45	MSW/ Shear strength, age
Zhao et al.	2014	DS, TCX	35.9–66.4	29–38	MSW/Degradation, moisture content
Babu et al.	2015	DS, TCX	0–10	55, 33	MBT waste in India/Unit weight, particle size

Fucale et al.	2015	DS	16	40.1	MBT waste in Germany/Fiber content
Abreu and Vilar	2017	DS	4.4	30	MSW/Composition, degradation
Feng et al.	2017	DS	18.3–29.1	15.7–21.9	MSW from Shanghai (China) landfills
Pulat and Yukselen-Aksoy	2017	DS	32–50	21–36	MSW/Fiber content, age
Ramaiah et al.	2017	DS	13–17	23–34	MSW/ Shear strength
Lakshmikanthan et al.	2018	TCX	5	32	MBT waste in India
Falamaki et al.	2019	DS	20.3–21.6	8–13	MSW/ Aeration
Bareither et al.	2020	DS	7	29	MSW/Moisture
This paper	–	TCX	1.0–8.2	16.2–29	MBT waste in Hangzhou (China)

Notes: a) c (kPa) cohesion; b) φ (°) internal friction angle; c) DS direct shear test; d) TCX triaxial test.

Table S2 Mechanical biological treatment waste components in dry mass.

Component	Content (%)
Plastic	23.06
Rubber	0.29
Textile	4.9
Wood	4.61
Stones, ceramics	14.15
Glass	20.65
Metal	2.67
Fines <5 mm	20.73
Unidentified >5 mm	8.94

Table S3 Coefficients *A* and *B* and correlation coefficient R^2.

Confining pressure (kPa)	*A*	*B*	R^2
50	61.57	14.12	0.964
100	130.42	24.93	0.827
200	254.91	62.32	0.967
300	321.87	45.27	0.997

Table S4 Coefficients *C* and *D* and correlation coefficient R^2.

Confining pressure (kPa)	*C*	*D*	R^2
50	87.17	20.72	0.945
100	177.38	37.03	0.850
200	347.64	83.58	0.958
300	417.07	45.27	0.982

Table S5 Cohesion and effective cohesion.

Loading rate (%/min)	Axial strain 5%		Axial strain 10%		Axial strain 15%		Axial strain 20%	
	c (kPa)	c´ (kPa)	c (kPa)	c´ (kPa)	c (kPa)	c´ (kPa)	c (kPa)	c´ (kPa)
0.25	2.3	4.1	4.0	8.6	5.1	10.2	8.2	14.9
0.5	2.1	3.7	3.3	7.4	4.8	9.4	7.2	12.8
1	1.7	2.9	3.1	6.3	4.5	8.5	6.0	10.2
2	1.6	2.6	2.6	5.9	4.1	7.7	5.4	8.8
4	1.0	2.1	2.3	4.7	3.3	6.6	4.5	7.3

Table S6 Coefficients E and F and correlation coefficient R^2.

Axial strain (%)	E	F	R^2
5	1.73	−1.12	0.950
10	3.04	−1.30	0.943
15	4.34	−1.39	0.924
20	6.27	−3.04	0.986

Table S7 Coefficients G and H and correlation coefficient R^2.

Axial strain (%)	G	H	R^2
5	3.04	−1.67	0.978
10	6.57	−3.06	0.969
15	8.48	−2.97	0.994
20	10.8	−6.39	0.978

Table S8 Internal friction angle and effective internal friction angle.

Loading rate (%/min)	Axial strain 5%		Axial strain 10%		Axial strain 15%		Axial strain 20%	
	φ (°)	φ′ (°)	φ (°)	φ′ (°)	φ (°)	φ′ (°)	φ (°)	φ′ (°)
0.25	16.2	19.8	20.1	27.1	21	32.1	22.4	38.8
0.5	17.4	20.9	21	28.8	23.5	33.2	25.6	40.9
1	18.4	22	21.9	29.3	24.1	34.1	26.5	42.3
2	19.4	22.6	23.4	29.8	25.5	34.5	27.8	43.3
4	20.7	23.5	23.8	30.1	26.2	34.9	29	43.9

Table S9 Coefficients I and J and correlation coefficient R^2.

Axial strain (%)	I	J	R^2
5	18.42	3.65	0.996
10	22.04	3.26	0.972
15	24.06	4.12	0.922
20	26.38	4.05	0.95

Table S10 Coefficients K and L and correlation coefficient R^2.

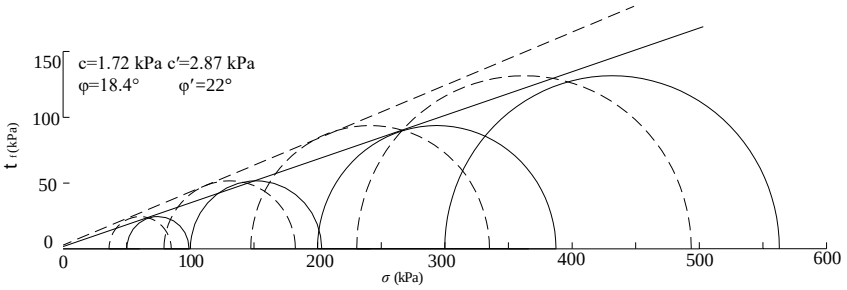
Axial strain (%)	K	L	R^2
5	21.76	3.02	0.985
10	29.02	2.33	0.836
15	33.76	2.29	0.928
20	41.84	4.18	0.933

(a) (b)

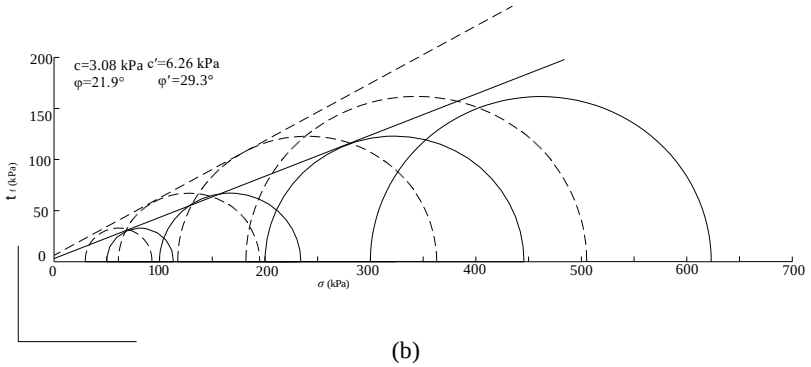
Fig. S1 Mechanical biological treatment waste: (a) untreated original waste material; (b) prepared waste used in tests.

(a) (b) (c)

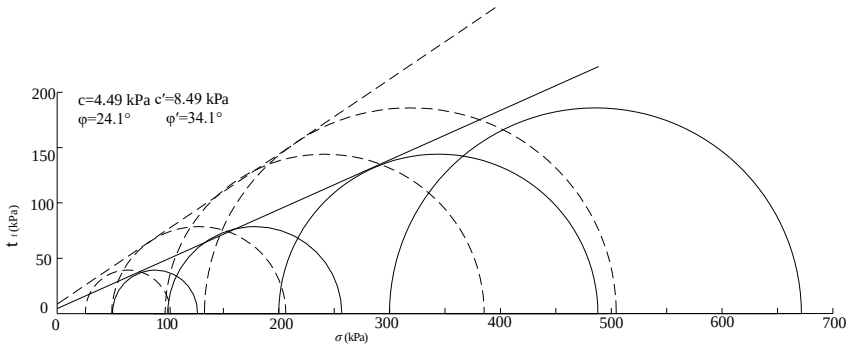
Fig. S2 Changes in sample during triaxial test: (a) before, (b) during, and (c) after the test.



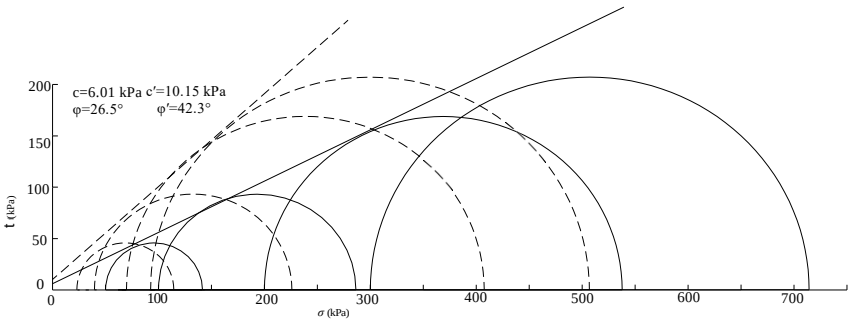
(a)



(b)



(c)



(d)

Fig. S3 Strength envelope of 1% per min loading rate at an axial strain of (a) 5%, (b) 10%, (c) 15%, and (d) 20%.

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