

Supplementary information

1 Materials

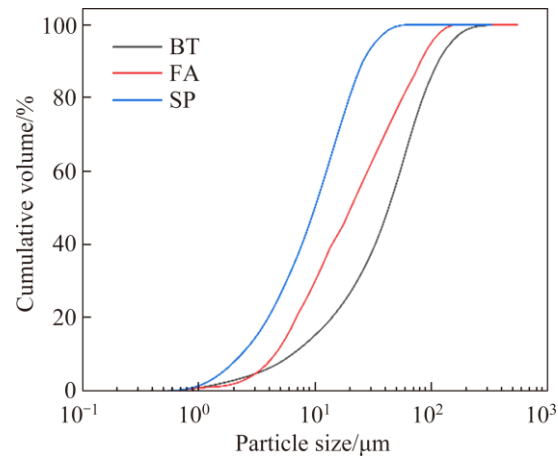


Figure S1 Particle size distribution curve of materials

Table S1 Main composition of materials

Material	wt%							
	CaO	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	Na ₂ O	K ₂ O	TiO ₂	MgO
BT	0.32	28.23	38.1	14.93	—	0.78	1.7	—
FA	3.7	50.8	28.1	6.2	1.2	0.6	—	1.2
SP	33.6	36.5	14.3	3.2	1.1	—	0.1	7.5
OPC	64.52	20.2	4.85	3.62	—	—	258	—

2 Experimental scheme

2.1 Mix proportions

Table S2 Proportion of FLSMB

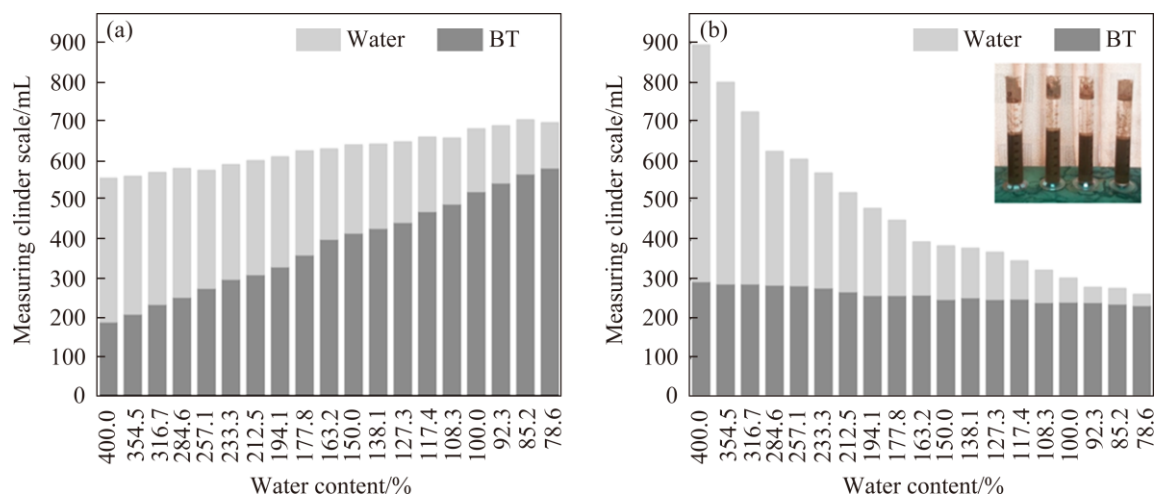
Mixture	Total binder/(kg·m ⁻³)	Cement/(kg·m ⁻³)	FA/(kg·m ⁻³)	SP/(kg·m ⁻³)	BT/(kg·m ⁻³)	Foam/(L·m ⁻³)	w/b ratio
D500F0S0	290	203	0	—	87	724	0.6
D500F10	290	183	20	—	87	724	0.6
D500F15	290	172	31	—	87	724	0.6
D500F20	290	162	41	—	87	724	0.6
D500S10	290	183	—	20	87	724	0.6
D500S20	290	162	—	41	87	724	0.6
D500S30	290	142	—	61	87	724	0.6
D700F0S0	419	293	0	—	126	600	0.6
D700F10	419	264	29	—	126	600	0.6
D700F15	419	249	44	—	126	600	0.6
D700F20	419	234	59	—	126	600	0.6
D700S10	419	264	—	29	126	600	0.6
D700S20	419	234	—	59	126	600	0.6
D700S30	419	205	—	88	126	600	0.6
D900F0S0	548	384	0.0	—	164	480	0.6
D900F10	548	345	39	—	164	480	0.6
D900F15	548	326	58	—	164	480	0.6
D900F20	548	307	77	—	164	480	0.6
D900S10	548	345	—	39	164	480	0.6
D900S20	548	307	—	77	164	480	0.6
D900S30	548	269	—	115	164	480	0.6

2.2 Measuring cylinder deposition test

The water content of the BTs varies regionally in the discharge impoundment. To utilize it directly, a gauge deposition test was designed to explore the deposition properties of the slurry. BTs were prepared for the same volume of water with different concentrations and the same volume of sludge with various concentrations, as shown in Table S3 and Figure S3. As seen in Figure S2, the mud-water separation ratio (ratio of water column height to deposited mud height) decreased with decreasing water content. The regression equation revealed a strong linear relationship between the actual water content and the mud-water separation ratio, as shown in Figure S3.

Table S3 Experimental scheme for BTs deposition tests using measuring cylinder

No.	Water content/%	500.0 g water	200.0 g mud consumption
		Mud consumption/g	Water consumption/g
1	400.0	125.0	800.0
2	354.5	141.0	709.1
3	316.7	157.9	633.3
4	284.6	175.7	569.2
5	257.1	194.4	514.3
6	233.3	214.3	466.7
7	212.5	235.3	425.0
8	194.1	257.6	388.2
9	177.8	281.3	355.6
10	163.2	306.5	326.3
11	150.0	333.3	300.0
12	138.1	362.1	276.2
13	127.3	392.9	254.5
14	117.4	425.9	234.8
15	108.3	461.5	216.7
16	100.0	500.0	200.0
17	92.3	541.7	184.6
18	85.2	587.0	170.4
19	78.6	636.4	157.1

**Figure S2** Slurry separation of BTs: (a) The same water volume; (b) The same sludge volume

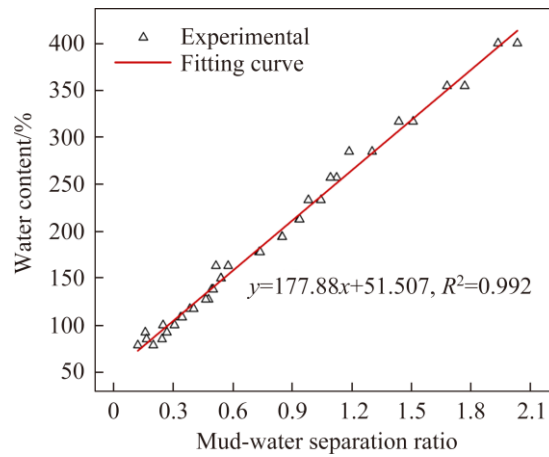


Figure S3 Relationship between mud-water separation ratio and water content

To further determine the accuracy of this regression equation, the difference between the fitted value and the actual value was calculated under different mud-water separation ratios, and the results are shown in Table S4. The calculations were extremely accurate at the same volume of water. The deviation of the fitted values from the measured values was also minor at the same volume of sludge, except for the separation ratios of 1.185 and 0.513, with deviations of -22.2% and -20.4% , respectively. Therefore, it is feasible to use the mud-water separation ratio to compute the water content of BTs quickly.

Table S4 Fitting and actual values of BTs water content

Mud-water separation ratio	500.0 g water			Mud-water separation ratio	200.0 g mud		
	Actual water content/%	Fitted water content/%	Difference/%		Actual water content/%	Fitted water content/%	Difference/%
1.937	400.0	396.0	-4.0	2.034	400.0	413.3	13.3
1.679	354.5	350.2	-4.3	1.768	354.5	366.0	11.5
1.436	316.7	306.9	-9.8	1.509	316.7	319.9	3.2
1.302	284.6	283.0	-1.6	1.185	284.6	262.4	-22.2
1.091	257.1	245.6	-11.5	1.123	257.1	251.2	-5.9
0.980	233.3	225.8	-7.5	1.043	233.3	237.0	3.7
0.935	212.5	217.9	5.4	0.933	212.5	217.5	5.0
0.848	194.1	202.4	8.3	0.846	194.1	202.0	7.9
0.736	177.8	182.4	4.6	0.731	177.8	181.5	3.7
0.575	163.2	153.8	-9.4	0.513	163.2	142.8	-20.4
0.538	150.0	147.3	-2.7	0.540	150.0	147.6	-2.4
0.500	138.1	140.4	2.3	0.492	138.1	139.0	0.9
0.463	127.3	133.8	6.5	0.476	127.3	136.2	8.9
0.401	117.4	122.9	5.5	0.382	117.4	119.5	2.1
0.343	108.3	112.5	4.2	0.335	108.3	111.0	2.7
0.305	100.0	105.7	5.7	0.247	100.0	95.4	-4.6
0.267	92.3	98.9	6.6	0.157	92.3	79.4	-12.9

2.3 Flowchart of specimen preparation

The samples were prepared as follows. Firstly, a certain number of binders were weighed and stirred evenly. Secondly, a corresponding foam was prepared and conveyed to the mixer to mix homogeneously. Next, the slurry was poured into 10 mm×10 mm×10 cm molds and placed in an indoor environment for 48 h before

removing the molds. Finally, specimens were cured at an environmental simulator generator (relative humidity $\geq 95\%$, temperature: $(20 \pm 2)^\circ\text{C}$ for 28 d. The specimen preparation process is shown in Figure S4.

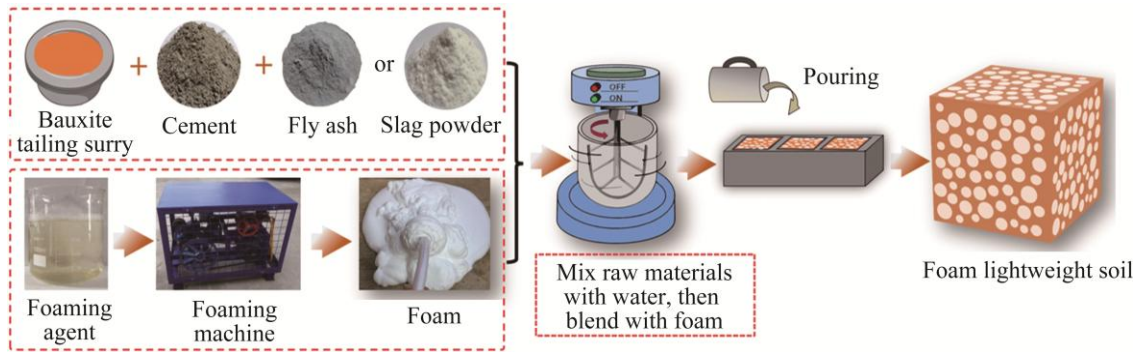


Figure S4 Specimen preparation process

3 Testing methods

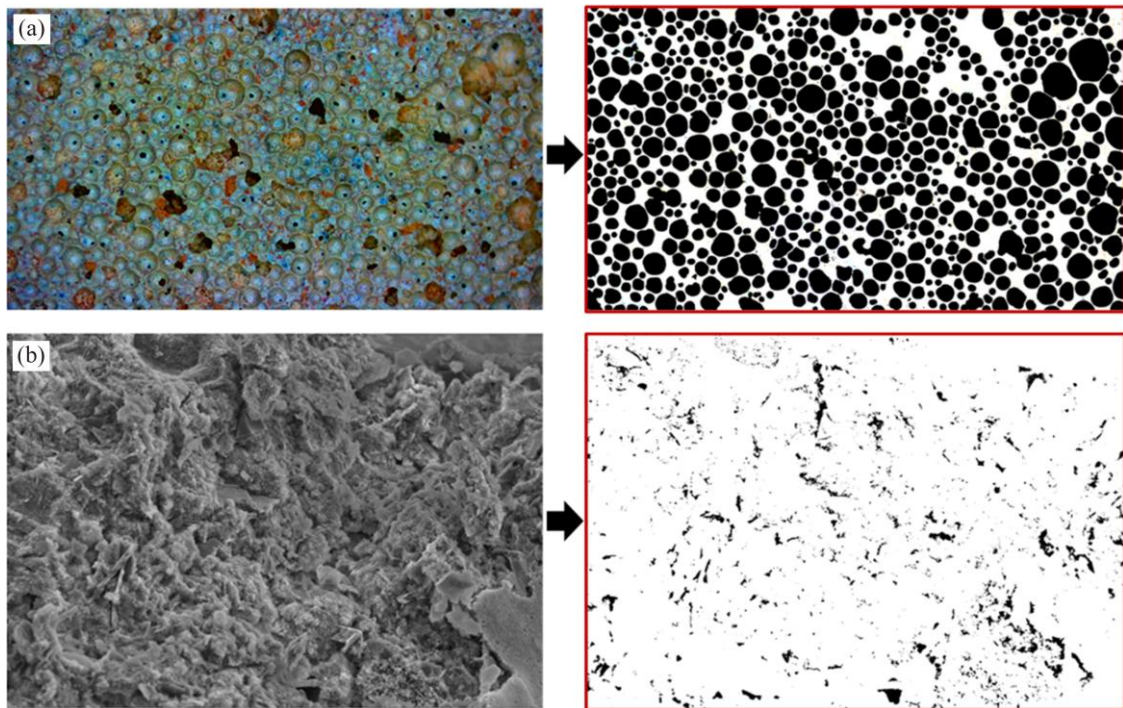


Figure S5 Schematic diagram of the binarization processing of SEM images: (a) Pore; (b) Skeleton