

SUPPLEMENTARY MATERIAL TO
Leaching of heavy metals from wood biomass ash, before and after binding in cement composite

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Table S-I. The results of the chemical analysis of tested biomass ashes

Component	Content, wt.%			
	Pd-BA	Pd-FA	E ₁	E ₂
SiO ₂	53.9	12.7	36.3	2.05
SO ₃	0.65	7.06	0.13	1.31
CaO	13.3	46.0	36.4	43.1
Al ₂ O ₃	4.46	4.69	7.71	0.83
TiO ₂	0.29	0.34	0.71	0.15
MgO	13.9	6.34	4.60	4.11
Na ₂ O	0.28	0.56	0.56	0.25
K ₂ O	5.06	11.9	5.19	12.5
Fe ₂ O ₃	3.11	3.47	5.45	0.27
MnO	0.37	0.49	0.57	2.24
TiO ₂	0.29	0.34	0.71	0.15

Table S-II. The results of the mineralogical analysis of tested biomass ashes

Component	Content, wt.%			
	Pd-BA	Pd-FA	E ₁	E ₂
Alite sum	24.5	27.5	7.94	11.3
Lime (CaO)	9.25	2.45	3.86	1.18
Calcite (CaCO ₃)	29.1	27.4	23.7	70.1
Quartz (SiO ₂)	8.14	12.0	34.9	0.80
Periclase (MgO)	13.9	8.86	1.67	4.15
Anhydrite (CaSO ₄)	0.00	0.00	0.00	0.00
Magnetite (Fe ₃ O ₄)	0.00	0.05	0.63	0.00

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Component	Content, wt. %			
	Pd-BA	Pd-FA	E ₁	E ₂
Hematite (Fe ₂ O ₃)	6.08	7.89	1.52	3.72
Thenardite (Na ₂ SO ₄)	9.11	13.9	3.74	8.81
Mullite	0.00	0.00	1.48	0.00
Rutile	0.00	0.00	1.73	0.00
Amorphous phase	0.00	0.00	18.9	0.00
Σ	100.08	100.05	100.07	100.06

Table S-III. Pseudo-total metal content for tested biomass ashes

Sample Metal	Pd ₁	Pd ₂	E ₁	E ₂	MAC for clay soils
	Content, mg kg ⁻¹				
As	7.72	8.73	2.26	6.75	20
Ba	1029	873	4343	1484	100
Cd	3.69	5.22	2.40	0.46	2
Co	15.1	12.3	14.5	15.4	60
Cr	151	193	143	223	120
Cu	88.3	83.5	204	86.2	120
Mn	2985	2546	24336	3961	–
Ni	214	84.9	310	133	75
Pb	34.6	34.6	22.5	21.8	150
Zn	394	685	316	189	200

Table S-IV. Concentrations of test metals obtained by Tessier SE for tested wood biomass samples

Fraction Sample Metal	Exchangeable				Carbonate			
	Pd ₁	Pd ₂	E ₁	E ₂	Pd ₁	Pd ₂	E ₁	E ₂
	Concentration, mg kg ⁻¹				Concentration, mg kg ⁻¹			
As	0.212	0.129	0.162	0.135	1.299	1.309	0.331	0.697
Ba	47.61	49.94	100.3	39.49	62.23	42.48	206.7	136.8
Cd	0.638	0.343	0.121	0.113	1.070	1.430	0.151	0.069
Co	0.011	0.012	0.008	0.011	0.418	0.335	0.044	0.395
Cr	1.285	2.021	0.831	0.750	8.274	3.422	2.877	5.956
Cu	0.853	0.789	0.655	0.720	7.964	7.153	35.39	5.167
Mn	0.260	0.274	2.892	1.800	133.3	93.35	44.37	238.4
Ni	0.159	0.283	0.286	0.174	4.115	2.862	15.25	3.502
Pb	11.52	12.18	0.743	6.501	6.875	6.123	0.780	2.427
Zn	2.315	2.792	2.035	4.740	83.37	100.3	9.345	10.58
	Fe and Mn				Organic			
	Pd ₁	Pd ₂	E ₁	E ₂	Pd ₁	Pd ₂	E ₁	E ₂
	Concentration, mg kg ⁻¹				Concentration, mg kg ⁻¹			
As	3.055	5.930	1.371	2.842	0.266	0.216	0.272	0.150
Ba	138.1	137.7	61.22	515.6	94.03	117.7	388.0	105.3
Cd	1.138	2.803	1.661	0.249	0.091	0.134	0.059	0.028
Co	7.086	10.15	10.92	7.655	0.372	0.378	0.159	0.315
Cr	24.49	36.08	20.42	37.25	8.844	8.994	25.50	10.77
Cu	22.61	40.04	94.98	65.82	14.33	11.47	12.15	10.54
Mn	1799	2320	18909	3013	62.79	69.95	160.0	76.00
Ni	33.09	49.80	183.8	50.66	2.923	2.515	4.889	3.418

Fraction	Exchangeable				Carbonate			
	Pb	14.85	14.77	5.075	8.809	0.697	1.030	1.234
Zn	210.1	454.7	201.8	91.83	8.545	8.891	12.95	11.66

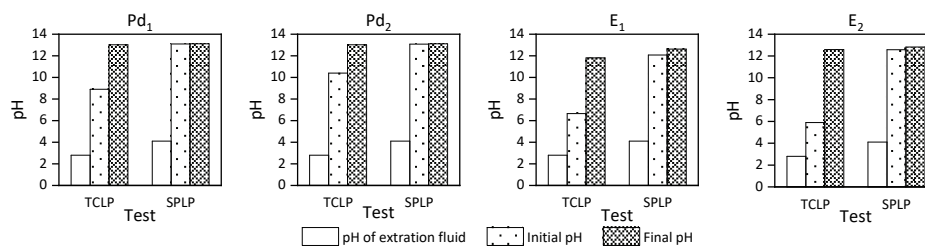


Fig. S-1. Change in pH value before and after performing single leaching tests

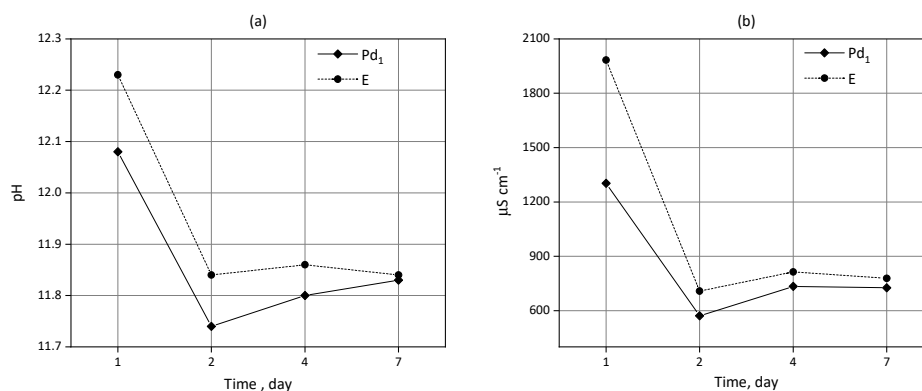


Fig. S-2. Change in pH value (a) and electrical conductivity (b) during leaching of cement composites in the tank

Table S-V. Metal concentrations in mg kg⁻¹ leached from the monolith, with the cement / ash ratio 65 : 35, at $T = 20\text{ }^{\circ}\text{C}$

Metal	Content, mg kg ⁻¹									
	Day 1		Day 2		Day 4		Day 7		PTMC	
	Pd ₁	E	Pd ₁	E	Pd ₁	E	Pd ₁	E	Pd ₁	E
Cr	0.326	0.757	0.112	0.078	0.117	0.059	0.328	0.200	398.9	811.9
Mn	0.014	0.019	0.011	0.010	0.005	0.010	0.007	0.011	3412	11538
Co	0.001	0.001	0.000	0.001	0.001	0.000	0.001	0.001	28.67	32.55
Ni	0.006	0.009	0.004	0.006	0.004	0.005	0.004	0.007	197.0	317.1
Cu	0.039	0.046	0.035	0.029	0.040	0.016	0.025	0.040	207.1	275.2
Zn	0.275	0.264	0.401	0.436	0.255	0.118	0.172	0.221	616.9	527.3
As	0.003	0.004	0.001	0.001	0.002	0.001	0.003	0.001	28.27	26.53
Cd	0.002	0.002	0.001	0.001	0.004	0.001	0.001	0.001	4.307	1.941
Ba	0.607	0.778	0.692	1.063	1.328	1.633	1.687	2.184	1206	2584
Pb	0.022	0.026	0.017	0.028	0.077	0.011	0.025	0.023	84.48	68.05