

Environmental performance

The LCA results show that the 1200mm BFRP reinforced concrete beam performs better across all eighteen environmental indicators compared to the 1250mm steel reinforced concrete beam. The BFRP reinforced concrete beam experiences 14.7 kgCO_{2eq}/FU of climate change emissions, whilst the steel reinforced concrete beam experiences almost double the amount of embodied emissions at 23.7 kgCO_{2eq}/FU.

When emission factors from EPDs for precast steel reinforced concrete beams were implemented, it was found that the GWP product stage emissions ranged from between 25.1 to 27.9 kgCO_{2eq}/FU [31-33]. This is in-line with the findings of this study. However, when emission factors from EPDs for poured concrete [34] and 100% recycled reinforcement steel [35] were used, it was found that GWP emissions were at 11.3 kgCO_{2eq}/FU for steel reinforced concrete beams, compared to 14.6 kgCO_{2eq}/FU for a BFRP reinforced concrete beam of a similar size.

It was observed that the BFRP and reinforcement steel datasets have similar emission factors: 2.6 and 2.34 kgCO_{2eq}/kg respectively. However, since BFRP has a lower specific weight to steel, and is three times lighter, the overall embodied emissions are much lower in BFRP reinforced concrete beams. In the BFRP reinforced concrete beams, the largest contributor to emissions was concrete (93.7%), followed by resin (5.5%), furnace electricity consumption (0.4%), mining and transport (0.4%). In the steel reinforced concrete beams, the largest contributor to emissions was concrete (56.2%), followed by steel (43.8%).

Table 3. Mid-point results per functional unit.

Impact Category	Unit	Steel RC (1250 x 200 x 189mm)	BFRP RC (3860 x 200 x 200mm)	BFRP RC (2700 x 200 x 200mm)	BFRP RC (2000 x 200 x 200mm)	BFRP RC (1200 x 200 x 200mm)
Climate change	kg CO ₂ eq	23.7	46.9	32.8	24.3	14.6
Ozone depletion	kg CFC ₁₁ eq	1.19E-06	2.29E-06	1.6E-06	1.18E-06	7.11E-07
Terrestrial acidification	kg SO ₂ eq	0.07	0.11	0.08	0.06	0.04
Freshwater eutrophication	kg P eq	5.71E-03	2.80E-03	1.97E-03	1.46E-03	8.76E-04
Marine eutrophication	kg N eq	0.012	0.023	0.016	0.012	0.007
Human toxicity	kg 1.4-DB eq	7.48	5.19	3.63	2.69	1.61
Photochemical oxidant formation	kg NMVOC	7.51E-02	0.13	0.09	0.07	0.04
Particulate matter formation	kg PM10 eq	4.65E-02	0.07	0.05	0.04	0.02
Terrestrial eco-toxicity	kg 1.4-DB eq	1.43E-03	2.2E-03	1.54E-03	1.14E-03	6.83E-04
Freshwater eco-toxicity	kg 1.4-DB eq	0.25	0.14	0.10	0.07	0.04
Marine eco-toxicity	kg 1.4-DB eq	0.25	0.14	0.10	0.07	0.04
Ionising radiation	kBq U235 eq	1.89	4.49	3.14	2.33	1.40
Agricultural land occupation	m ² a	0.42	0.70	0.49	0.37	0.22
Urban land occupation	m ² a	0.25	0.44	0.31	0.23	0.14
Natural land transformation	m ²	2.78E-03	5.71E-03	4.00E-03	2.96E-03	1.78E-03
Water depletion	m ³	0.25	0.60	0.42	0.31	0.19
Metal depletion	kg Fe eq	8.86	1.15	0.80	0.60	0.36
Fossil depletion	kg oil eq	3.52	5.89	4.12	3.05	1.83

