

**Online supplementary material for**

**Do fiber-reinforced polymer composites provide environmentally benign alternatives? A life-cycle-assessment-based study**

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**Table S-I. Material indicators<sup>a</sup> for minimal impacts in the production phase<sup>1</sup> and values for various materials.**

**(a) Material indicators**

Function	Material indicator
Minimal weight for given bending stiffness (panel)	Maximize $E^{1/3}/\rho$
Minimal weight for given bending strength (panel)	Maximize $\sigma^{1/2}/\rho$
Minimal CED for given bending stiffness (panel)	Minimize $\rho \times \text{CED}/E^{1/3}$
Minimal GHG for given bending stiffness (panel)	Minimize $\rho \times \text{GHG}/E^{1/3}$
Minimal ecopoints for given bending stiffness (panel)	Minimize $\rho \times \text{mPt}/E^{1/3}$
Minimal CED for given bending strength (panel)	Minimize $\rho \times \text{CED}/\sigma^{1/2}$
Minimal GHG for given bending strength (panel)	Minimize $\rho \times \text{GHG}/\sigma^{1/2}$
Minimal ecopoints for given bending strength (panel)	Minimize $\rho \times \text{mPt}/\sigma^{1/2}$

**(b) Values of material indicators for different materials**

	$E^{1/3}/\rho$	$\sigma^{1/2}/\rho$	$\frac{\rho \times \text{CED}}{E^{1/3}}$	$\frac{\rho \times \text{GHG}}{E^{1/3}}$	$\frac{\rho \times \text{mPt}}{E^{1/3}}$	$\frac{\rho \times \text{CED}}{\sigma^{1/2}}$	$\frac{\rho \times \text{GHG}}{\sigma^{1/2}}$	$\frac{\rho \times \text{mPt}}{\sigma^{1/2}}$
Epoxy/carbon fiber composites <sup>2</sup>	1.3	5.2	NA	NA	350	NA	NA	87.5
Thermoset polyester glass SMC <sup>2</sup>	1.8	5.9	NA	NA	490	NA	NA	149
Mild steel <sup>3</sup>	0.7	2.2	29.4	2.7	221.8	9.34	0.86	74.9
Al99.9(1090) <sup>4</sup>	1.5	3.1	103.3	6.7	687.2	50.2	3.24	338.5
Stainless steel <sup>2</sup>	0.7	3.8	60–103	5.4	713.9	11.1–19	1.0	140.9
Plain concrete <sup>4</sup>	1.2	1.5	0.5	0.09	3.7	0.39	0.07	3.0

NA, not available.

Acronyms: CED, cumulative energy demand; GHG, greenhouse gas; mPt, milli-ecopoints; SMC, sheet-molding-compound composite.

<sup>a</sup> $E$ , elastic modulus (GPa);  $\sigma$ , ultimate strength (MPa);  $\rho$ , density ( $\text{g}/\text{cm}^3$ ).

## References

1. M.F. Ashby, *Materials Selection in Mechanical Design* (Butterworth-Heinemann, Boston, MA, 3 ed., 2005).
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3. D. Codd, *Advanced, Lightweight Materials Development and Technology for Increasing Vehicle Efficiency* (KVA Incorporated, Escondido, CA, 2008).
4. *Matbase: Mechanical, physical and environmental properties of materials* (Matbase VOF, Delft, The Netherlands), <http://www.matbase.com/> (accessed January 2012).