BAS Carbon

Comparative

LCA REPORT

Renco Products

Report to: Renco USA, Inc.

Prepared by: BAS Carbon, bascarbon.com

Date: May, 2022

Unit 309, 111 3rd Street East
North Vancouver, BC V7M 2G1
Canada

T: 236.990.0664
info@bascarbon.com
www.bascarbon.com

May 5, 2022

Kenneth Smuts
Renco USA, Inc.

Re: final report – comparative environmental impacts of Renco construction products

Dear Mr. Smuts,

Please find below the revised report on the environmental impacts of Renco construction blocks and structural profile, in comparison with similar products by the market competition.

Please feel free to let me know if you require any further information. Thank you very much for the opportunity to submit this report.

Sincerely,

Rahman Azari, Ph.D.
BAS Carbon, Co-founder and Principal
rahman.azari@bascarbon.com

Report

Renco USA, Inc., produces Mineral Composite Fiber-Reinforced (MCFR) construction blocks, and structural joist and deck units in the Renco manufacturing facility located in Manisa, Turkey. The blocks and units stack in a simple interlocking arrangement and are adhesively integrated to form a monolithic housing structure.

MCFR Blocks

The Renco's MCFR blocks are composed of PET Recycled Resin (20-25%), Calcium Carbonate (30-40%), E-Glass Multi End Roving (15-25%), Aluminum Hydroxide (10-20%), and other contents (<5%).

In terms of application, MCFR blocks are comparable to Construction Masonry Units (CMU) that are used as a layer in building enclosure elements such as walls. CMUs are usually made by mixing Portland cement, water, and aggregates, into solid or hollow forms. As compared with CMUs which range in density from 1375 kg/m3 to 2870 kg/m3, MCFR blocks offer the density of 244 kg/m3, and thus provide a more lightweight solution to construction. In other words, MCFR blocks weigh between 9% and 18% of the weight of CMU blocks of similar size. The cradle-to-gate embodied carbon of MCFR blocks is at about 1 kilogram (kg) of CO2-equivalent per kg of mass, and 242 kg of CO2-equivalent per cubic meter of volume. Compared with some of the cement-based CMU blocks manufactured in North America and internationally, MCFR blocks have higher embodied content per unit of mass. However, when MCFR blocks are compared with CMUs per unit of volume (in cubic meter or cubic foot) which is a more fair basis for the comparison, MCFR blocks have an embodied carbon that is below the average or median embodied carbon intensity of some other products we reviewed. Also, when compared with the typical CMU block manufactured in North America as reported by the Carbon Leadership Forum material baseline (CLF 2021) and EC3 tool, the production of Renco's MCFR blocks leads to 35% lesser cradle-to-gate CO2-equivalent emissions. Table 1 shows the embodied carbon values of the products examined in this study. Fig. 1 illustrates the comparative embodied carbon.

Table 1. Cradle-to-Gate embodied carbon (A1, A2, A3) of the MCFR blocks, per kilogram of mass and per cubic meter of volume, in relation to competition.

	Cradle-to-Gate **Embodied Carbon** per **kg** of mass (kg CO2-e)	Cradle-to-Gate **Embodied Carbon** per **m3** of volume (kg CO2-e)	**Density** (kg/m3)
Hollow CMU, Hard Block Factory, UAE	0.1262	353.0	2796
Solid CMU, Hard Block Factory, UAE	0.0913	253.0	2770
Thermal CMU, Hard Block Factory, UAE	0.1440	254.0	1763
Hourdi CMU, Hard Block Factory, UAE	0.1323	373.0	2819
MCFR Block, Renco, Turkey	0.9940	242.0	244
Typical CMU block, according to CLF baseline	-	370.0	-
Light-weight hollow CMU, CCMPA, Canada	0.1479	270.0	1825
Normal-weight hollow CMU, CCMPA, Canada	0.1155	260.0	2250
Medium-weight hollow CMU, RCP, USA	0.1341	385.0	2870
HCR hollow CMU, RCP, USA	0.1596	538.0	3370
Segmental retaining wall block, Midwest, USA	0.1231	205.0	1665
Emcon solid block, UAE	0.0960	204.0	2125
Emcon hollow block, UAE	0.1258	173.0	1375
Emcon thermal block, UAE	0.1653	239.0	1445

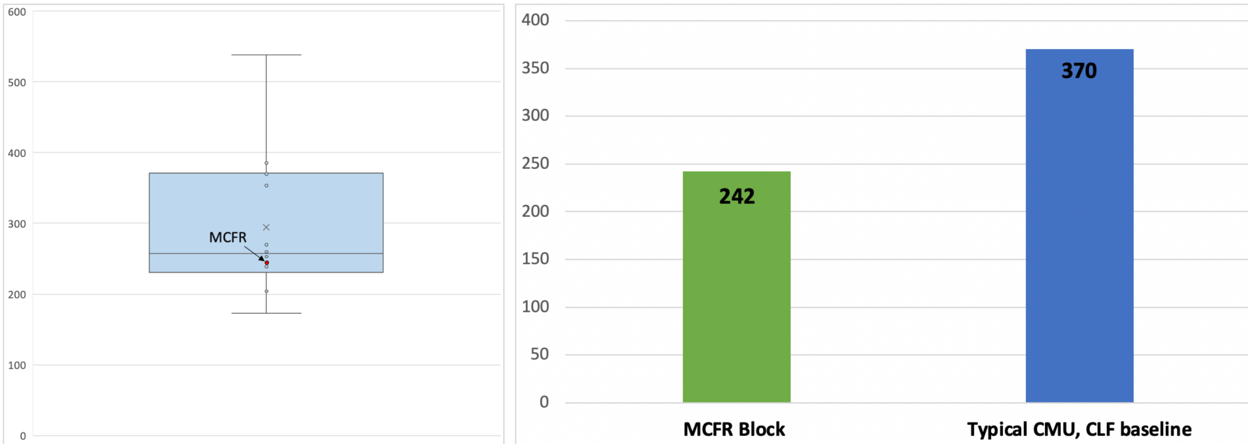

Fig. 1. *(left)* Embodied carbon (kg CO2-eq) per m3 of MCFR blocks is less than the average and median of the embodied carbon per m3 of CMU blocks studied in this review. *(right)* Embodied carbon (kg CO2-eq) per m3 of MCFR blocks is 35% less than the baseline for typical CMU defined by the Carbon Leadership Forum (CLF).

MCFR Profiles

The MCFR structural profiles consist of E-Glass Multi End Roving (55-65%); PET Recycled Resin (25-30%), Continuous Filament Mat (8-15%), ATH Aluminum Hydroxide (4.5-7%), Calcium Carbonate (3-4%), and other contents (<5%).

We studied the environmental impacts of a hollow MCFR joist of 0.35m deep by 0.06 m wide by 6.096 meter long in relation to comparable structural elements including hot-rolled steel I-beam, and cast-in-place concrete beam. Assuming at least the same service and ultimate load capacities, we estimated dimensions and volumes of alternative structural elements based on closest sizes standard to industry. Table 2 lists the structural alternatives for an MCFR joist along with their dimensions, density, mass per functional unit, volume per functional unit, and embodied carbon values per kg of mass, m3 of volume, and functional unit. Appendix 1 provides further structural data.

Table 2. Cradle-to-Gate embodied carbon of the MCFR joist, as compared with other structural alternatives.

	Dimensions (cm)	**Density** (kg/m3)	**Mass** (kg) per FU	**Volume** (m3) per FU	**Embodied Carbon (kg CO2-e)**		
					per kg of mass	per m3 of volume	per Functional Unit
Hollow MCFR joist	6×35×609.6	327	10.09	0.03087	2.00	654.00	20.02
Reinforced concrete	10×28×609.6	2404	416.00	0.173	0.12	311.47	53.9
Steel I beam	10×20×609.6	7800	90.71	0.011	1.22	9544.70	111.0

The comparison of embodied carbon results across different structural alternatives shows that per kilogram of mass, the MCFR joist has the highest embodied carbon, followed by steel I-beam (Fig. 2, top left). Per volume, steel I-beam has the highest embodied carbon, followed by the MCFR joist with a large distance (Fig. 2).

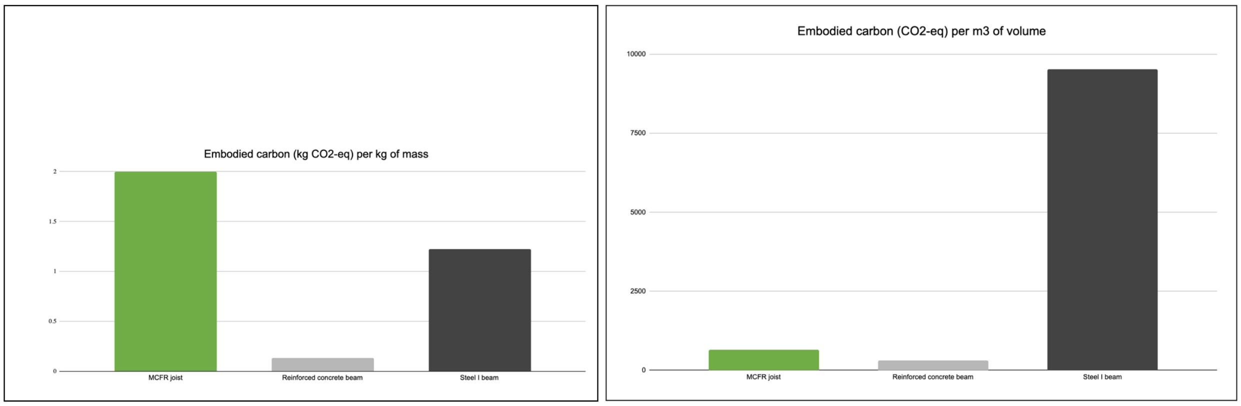

Fig. 2. *(left)* Cradle-to-gate Embodied carbon (kg CO2-eq) per kg of hollow MCFR joists as compared with other structural alternatives. *(right)* Embodied carbon (kg CO2-eq) per m3 of hollow MCFR joists as compared with other structural alternatives.

However, comparing structural alternatives is more meaningful when they are designed for the same load capacity. This would lead to the alternatives with different dimensions, mass, and volumes; but all with the capacity to carry the similar loads; hence the same functional unit. The comparison of embodied carbon values per functional unit (Fig. 3, top left) shows that the hollow MCFR joist has about 82% less embodied carbon than steel I-beam, and about 62% less embodied carbon than reinforced concrete.

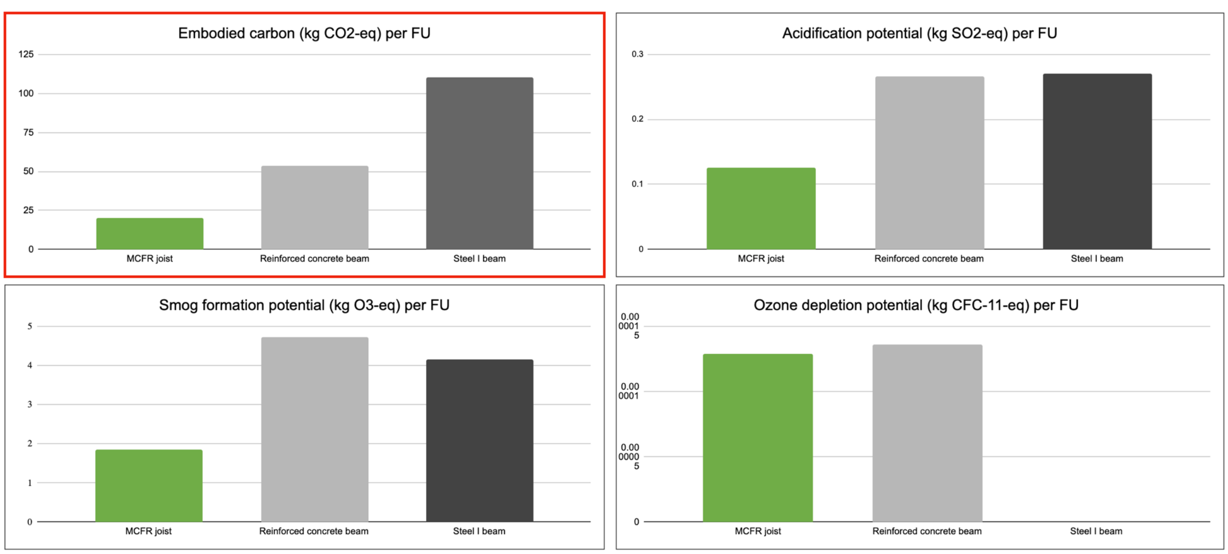

Fig. 3. Cradle-to-gate Embodied carbon *(top left)*, Acidification Potential *(top right)*, smog formation potential *(bottom left)*, and ozone depletion potential *(bottom right)* of hollow MCFR joists as compared with other structural alternatives.

As shown in Fig. 3, the hollow MCFR has a lower acidification potential than reinforced concrete beam and steel I-beam. It also has the lowest smog formation potential among the alternatives reviewed in this work. Additionally, MCFR joist offers a lesser ozone depletion potential than reinforced concrete beam.

Appendices 2 and 3 provide further details on other environmental impacts of MCFR joists as compared with other structural alternatives.

References

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Appendix 1. Service load capacity of various structural alternatives in this study.

	Dimensions (cm)			Service Load Capacity		
	Width	Height	Length	L/240	L/360	L/480
Hollow MCFR joist	6	35	609.6	135	90	60
Reinforced concrete beam	10	28	609.6	140	105	83
Steel I-beam	10	20	609.6	248	166	124

Appendix 2. Per-unit environmental impacts of MCFR joist and structural alternatives.

Product	**Hollow MCFR joist**	**Concrete**	**`Rebar**	**Steel I Beam**
Manufacturer	Renco	Maschmeyer	Concrete Reinforcement Steel Institute	American Institute of Steel Construction
Location	Turkey	Florida	USA	North America
Boundaries	A1, A2, A3	A1, A2, A3	A1, A2, A3	A1, A2, A3
Unit of Analysis	**1 kg**	**1 m3**	**1 kg**	**1 kg**
Density (kg/m3)	327	-	7.80E+03	7.80E+03
Global Warming Potential (kg-CO2eq)	2.00E+00	2.32E+02	9.79E-01	1.22E+00
Acidification Potential (kg-SO2eq)	1.25E-02	1.15E+00	4.75E-03	2.98E-03
Eutriphication Potential (kg-PO4eq)	6.43E-03	-	-	-
Eutriphication Potential (kg-Neq)	-	2.90E-01	1.86E-04	1.56E-04
Smog Formation Potential (kg-O3eq)	1.84E-01	2.26E+01	5.91E-02	4.58E-02
Ozone Depletion Potential (kg CFC-11-eq)	1.28E-07	7.85E-06	1.57E-10	1.63E-12

Appendix 3. Per-Functional Unit (FU) environmental impacts of MCFR joist and structural alternatives.

Product	**Hollow MCFR joist**	**Concrete joist**	**Steel I Beam**
Manufacturer	Renco	Maschmeyer	American Institute of Steel Construction
Location	Turkey	Florida	North America
Boundaries	A1, A2, A3	A1, A2, A3	A1, A2, A3
Unit of Analysis	0.06×0.35×6.0m 0.03087 m3 10.0945 kg	0.10×0.28×6.0m 0.1730 m3 401.85 kg concrete 14.140 kg rebar	0.10×0.20×6.0m 90.71 kg
Density (kg/m3)	327	2404	7800
Global Warming Potential (kg-CO2eq)	2.02E+01	5.39E+01	1.11E+02
Acidification Potential (kg-SO2eq)	1.26E-01	2.66E-01	2.70E-01
Eutriphication Potential (kg-PO4eq)	6.49E-02	-	-
Eutriphication Potential (kg-Neq)	-	5.28E-02	1.42E-02
Smog Formation Potential (kg-O3eq)	1.86E+00	4.74E+00	4.15E+00
Ozone Depletion Potential (kg CFC-11-eq)	1.29E-06	1.36E-06	1.48E-10