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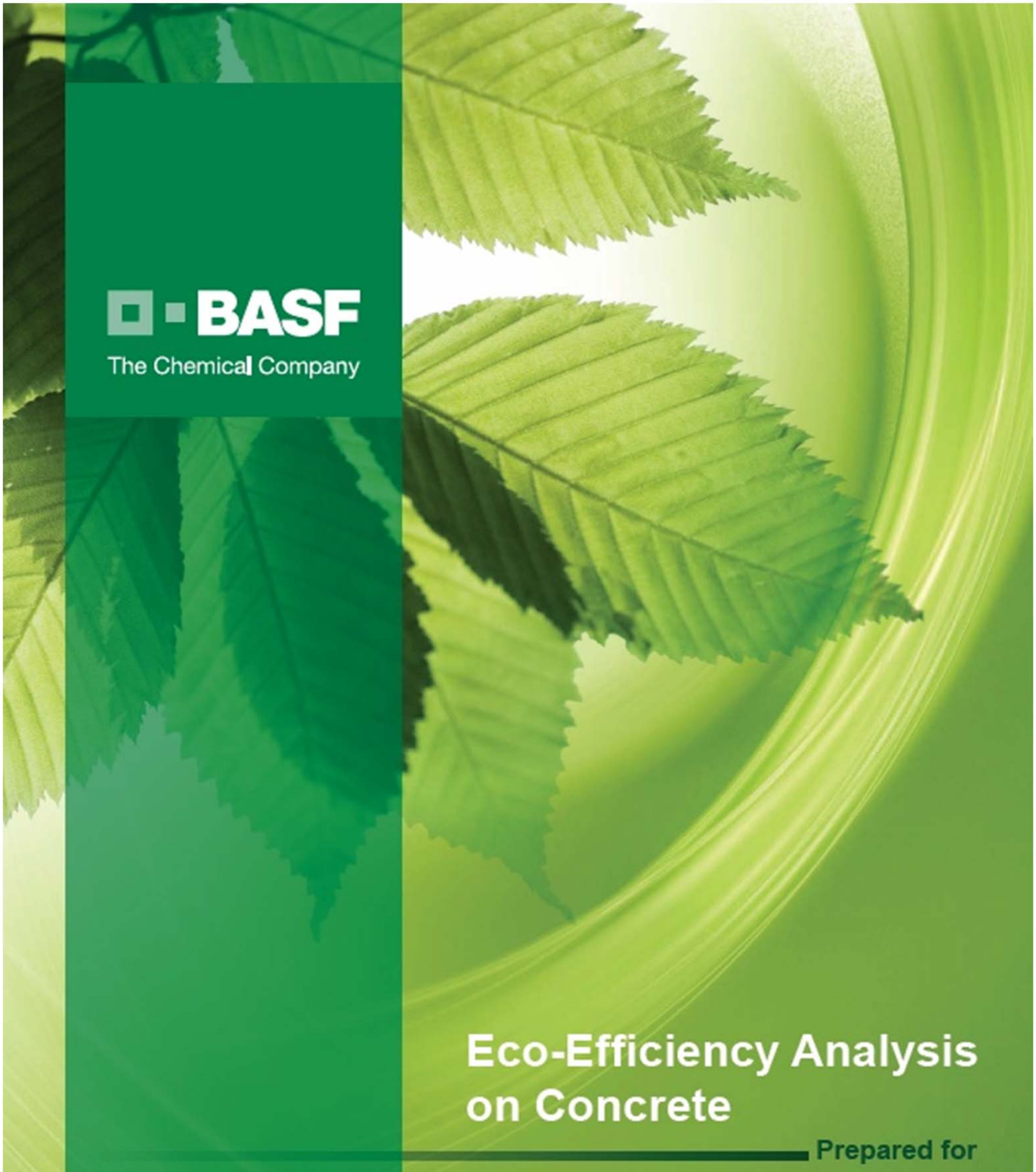


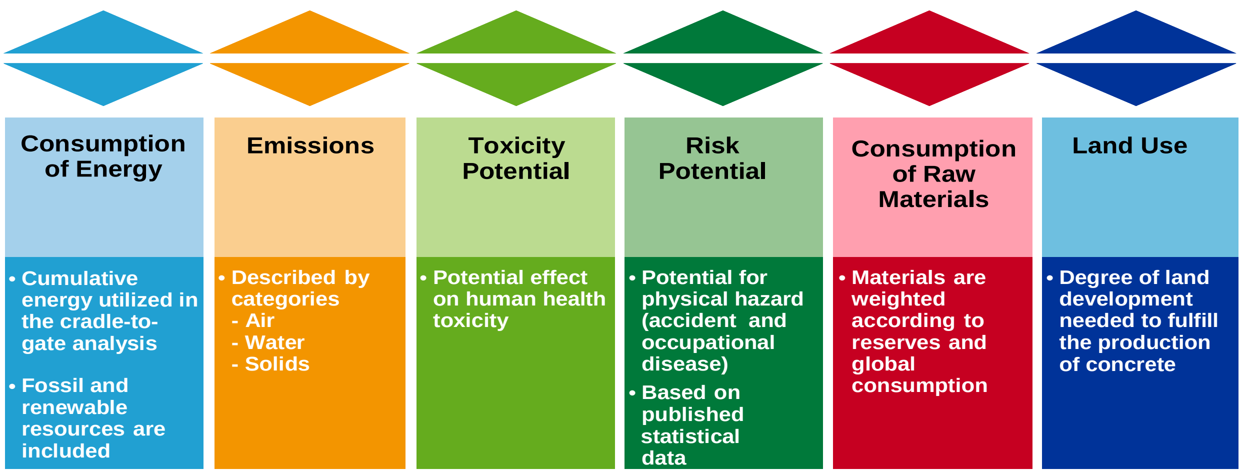
Mix Optimization 3,000 psi air
Allied Concrete Company
Charlottesville, VA

"Building a Sustainable Future."

Overview

BASF's Eco-Efficiency Analysis (EEA) is a strategic environmental life-cycle assessment that can be used to ensure sustainable construction practices. Data acquisition and calculations used in BASF's EEA are in accordance with ISO standards 14040 and 14044 for life cycle assessment. The methodology has been third party validated by TUV and NSF International.

The EEA compares the relative ecological and economical impacts of concrete mixtures and determines the best performing, most economical concrete mixture with the least environmental impact. Eco-Efficiency Analysis focuses on the effects of concrete ingredients and mixture proportions on environmental impact categories including, energy consumption, emissions (air, water, and solid waste), toxicity potential, risk potential, consumption of raw materials, and land use.



For this analysis, it is assumed that the plastic and hardened properties of the alternative concrete mixes are equal to or better than the properties of the reference mixture. It is recommended that laboratory and field evaluations are conducted to ensure the desired level of concrete performance is achieved. The following inputs were used in the analysis.

Production Data:

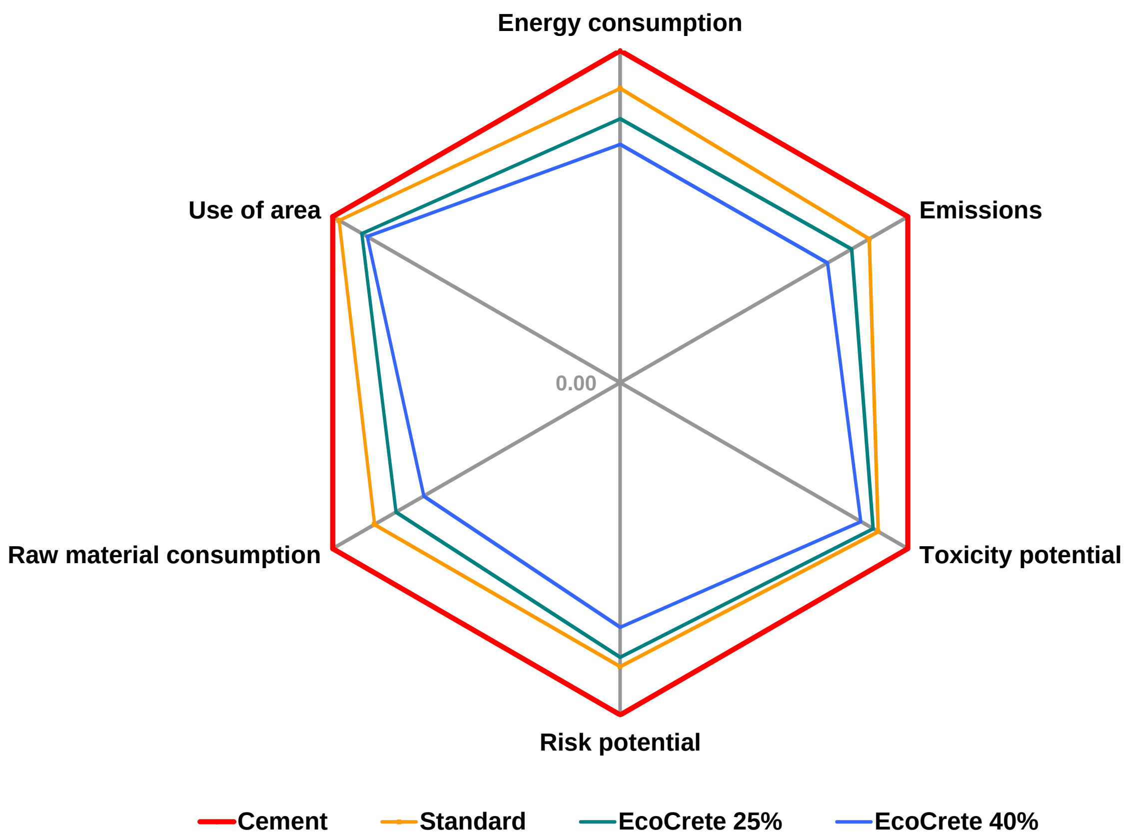
Concrete Volume (yd^3)	15,000
# of plants	1
Total Volume (yd^3)	15,000

Raw Material Transportation Mode and Distance:

	Mode and Distance	
Cement and Powder	Mode	Miles
Cement	Truck	156
Fly Ash	Truck	175
Aggregates		
Fine Aggregate #1	Truck	94
Coarse Aggregate #1	Truck	15
Coarse Aggregate #2	Truck	15

Environmental Fingerprint

The Eco-Efficiency Analysis evaluates the environmental life-cycle of concrete mixtures beginning with extraction of raw materials through the production of concrete. The use and disposal phases of traditional environmental life-cycle analyses are assumed to be identical for all the concrete mixtures considered in this analysis. The "environmental fingerprint" provides a picture of the environmental impact of concrete in the six key categories described earlier. Each alternative concrete mixture is then compared to the reference mixture. The closer the concrete mixture moves toward the center, the lower its impact on the environment. The axes are mutually independent, for example if one concrete mix does well in one impact category, this same mix can do less well with regard to another category. The environmental fingerprint for all the concrete mixtures evaluated in this analysis are shown below.



Environmental Impact Overview

For this analysis, the table below provides an overview of the environmental impacts of producing a unit volume of concrete from each mix design.

Parameter	Cement	Standard	EcoCrete 25%	EcoCrete 40%
Energy (kWh/yd^3)	842	746	669	604
Res. Consumption (lb/yd^3)	90	77	70	62
Fossil Fuel Consumption (lb/yd^3)	44	40	35	33
GHG (lbCO_2eq/yd^3)	651	532	502	424
POCP (lbEthene eq/yd^3)	0.179	0.164	0.144	0.132
AP (lbSO_2eq/yd^3)	4.6	3.8	3.6	3.1
Water emissions (gal/yd^3)	533	477	401	382
Solid Waste (lb/yd^3)	111	103	101	96
Land Use (ft^2/yd^3)	370	362	332	326

GHG is Greenhouse Gas or "Global Warming"
POCP is Photochemical Oxidation Creation Potential also known as "Summer Smog"
AP is Acidification Potential also known as "Acid Rain"

Change (%) in Environmental Impact

The table below provides an overview of the % difference (+ improve/- regress) from the Reference Mix to the alternative mixes chosen based on the results from the Environmental Impact Overview table above.

Parameter	Cement	Standard	EcoCrete 25%	EcoCrete 40%
Energy (kWh/yd^3)	842	11.4%	20.5%	28.2%
Res. Consumption (lb/yd^3)	90	14.6%	22.0%	31.7%
Fossil Fuel Consumption (lb/yd^3)	44	8.9%	19.8%	26.1%
GHG (lbCO_2eq/yd^3)	651	18.4%	23.0%	34.9%
POCP (lbEthene eq/yd^3)	0.179	8.7%	19.9%	26.2%
AP (lbSO_2eq/yd^3)	4.6	16.9%	22.4%	33.3%
Water emissions (gal/yd^3)	533	10.6%	24.8%	28.4%
Solid Waste (lb/yd^3)	111	7.1%	8.2%	13.4%
Land Use (ft^2/yd^3)	370	2.2%	10.2%	12.0%

Water Savings

The tables below quantify the annual water consumption savings, and practical equivalents relative to the reference mix, that can be achieved using BASF's water-reducing chemical admixtures in concrete.

Water Saved - Truck Washout and Bottled Water				
Alternative	Water Saved (gal / yd^3)	Annualized Water Saved (gal / yr)	Equivalent Annualized Number of Truck Washouts	Equivalent Number of 1 / 2 liter Bottles of Water
Standard				
EcoCrete 25%	0.70	10,529	47	79,706
EcoCrete 40%	2.55	38,319	170	290,074

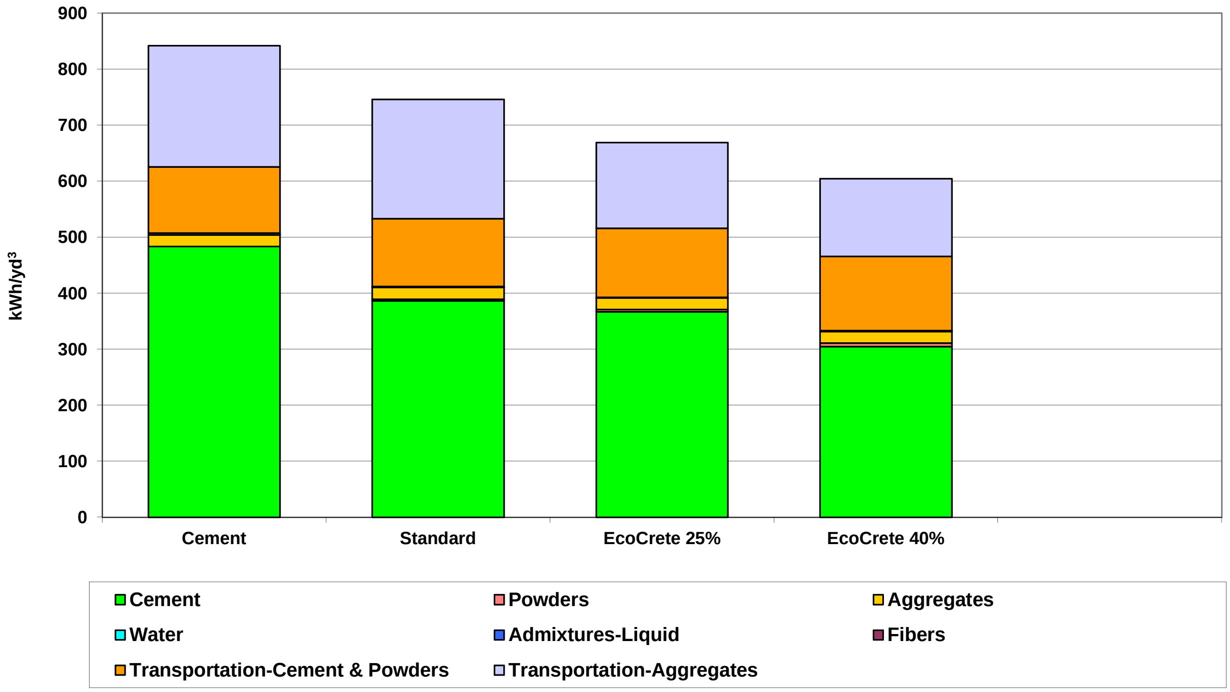
Assuming water required for washout is 225 gal/truck

Water Saved - Laundry and Shower Equivalence				
Alternative	Water Saved (lb / yd^3)	Annualized Water Saved (lb / yr)	Annualized # Loads of Laundry Saved (loads / yr)	Annualized # Showers Saved (showers / yr)
Standard				
EcoCrete 25%	5.8	87,750	263	841
EcoCrete 40%	21.3	319,350	957	3,062

Assuming water consumption of 334 lb/load of laundry and 104 lb/shower

Energy Consumption

The energy consumption category evaluates all of the factors involved in producing a unit volume of concrete (transportation, admixtures, water, aggregates, etc.). The analysis calculates the energy required from extraction to end use for each component. All forms of energy are converted back to the primary energy source, including coal, oil, gas, lignite, nuclear energy, biomass and others. The individual values are summed to obtain the total primary energy consumption. The bar graph shows the total energy consumption and the contribution of each raw material (including transportation to the batch plant) for each concrete mixture.



The table below quantifies the energy, and provides the practical equivalent, that could be saved by producing alternative mixes relative to the reference benchmark.

Energy Saved - US Homes Equivalent			
Alternative	Energy Saved (kWh/yd^3)	Annualized Energy Saved (kWh/yr)	Annualized US Energy Savings Equivalent (homes/yr)
Standard	96	1,439,916	124
EcoCrete 25%	173	2,595,487	224
EcoCrete 40%	238	3,564,535	308

Assuming annual energy usage is 11,571 kWh/yr for an average US home

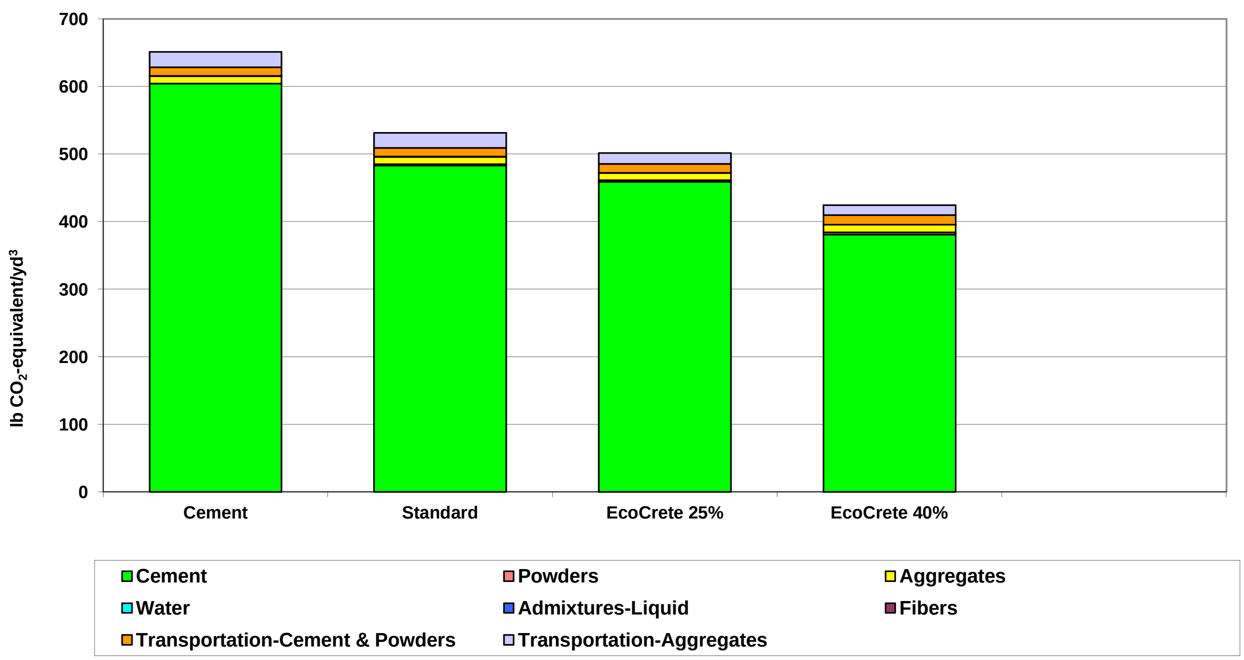
Emissions – Air

For the air emissions impact category, the following measurements are taken into consideration in the EEA:

1. green house gas (GHG)
2. photochemical ozone creation potential (POCP - summer smog)
3. acidification potential (AP - acid rain)
4. ozone depletion potential (ODP)

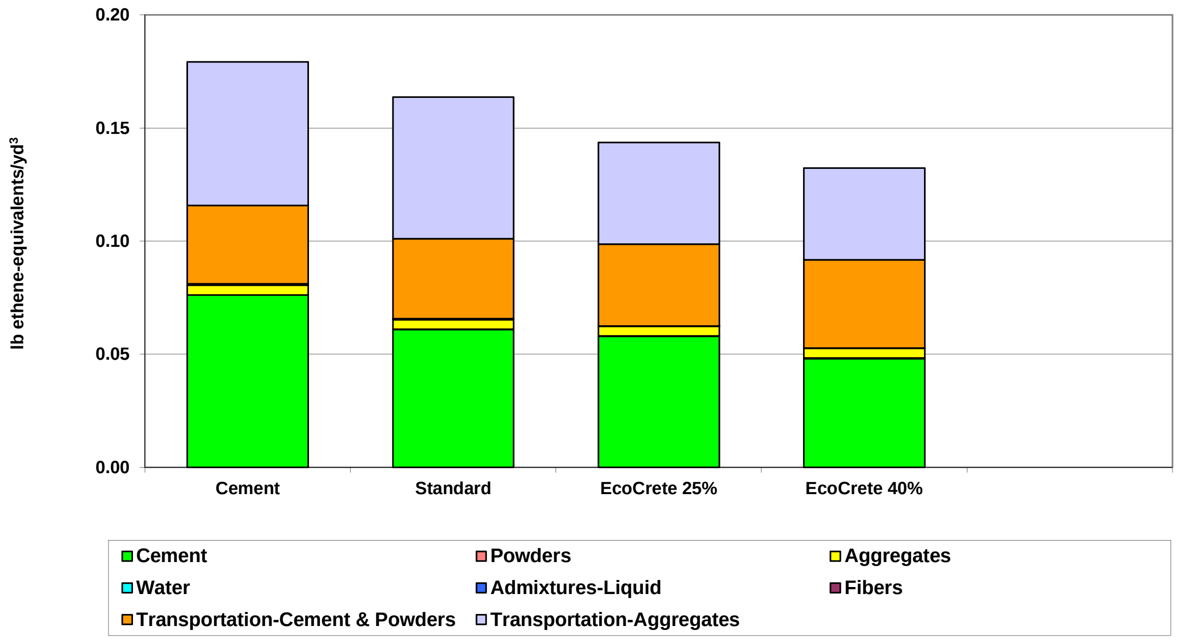
The air emissions calculation considers the amount of material emitted as well as the material's potency regarding GHG, ODP, POCP, and AP. The following graphs display the air emissions (i.e. mass of emissions generated per unit volume of concrete produced) for each concrete mixture considered in this analysis.

Green House Gas

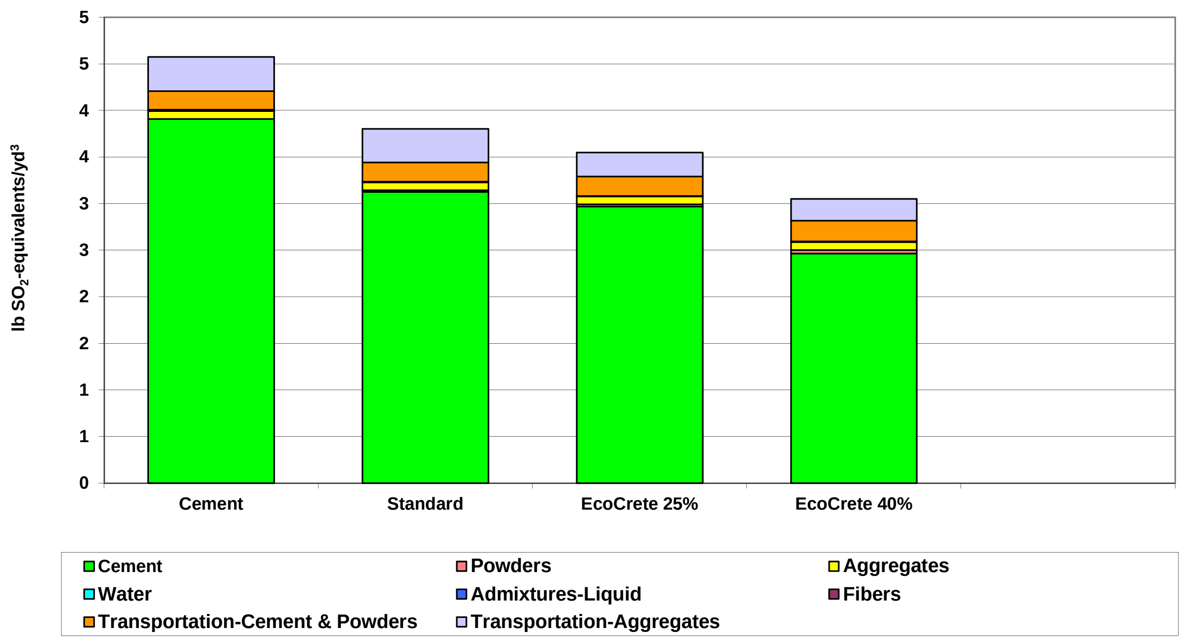


Emissions – Air (cont.)

Photochemical Ozone Creation Potential (POCP - Summer Smog)



Acidification Potential (Acid Rain)



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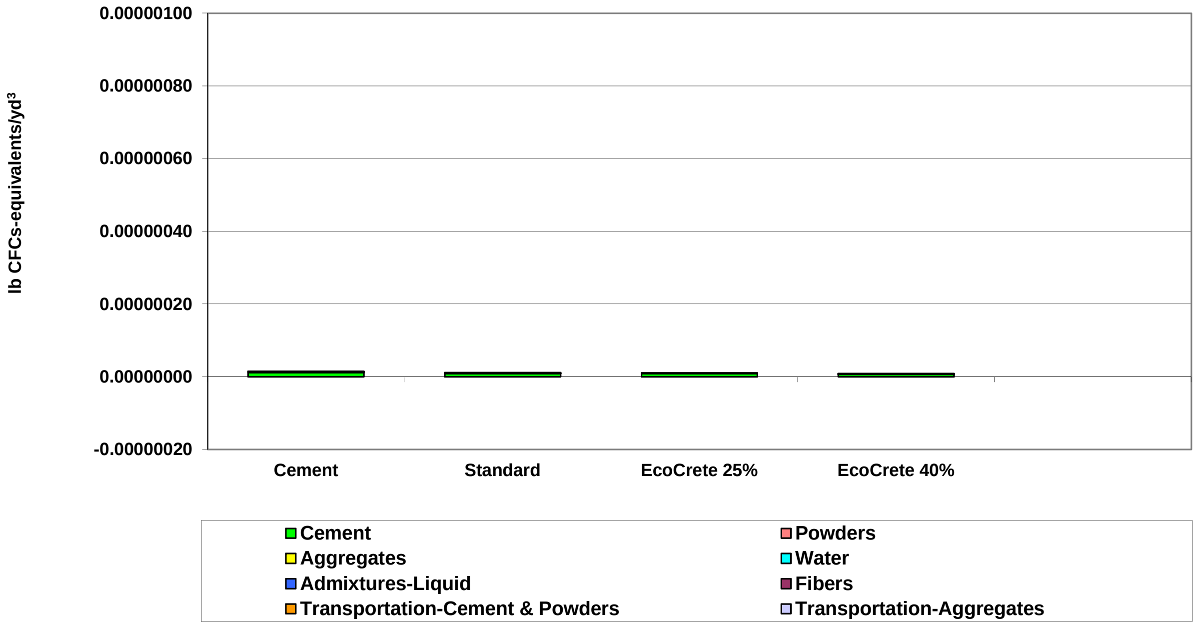
Emissions – Air (cont.)

Ozone Depletion Potential



Emissions – Air (cont.)

The tables below quantify the emissions, and provide practical equivalents, saved by producing alternative concrete mixes relative to the reference benchmark.

Smaller Carbon Footprint - CO_2 Uptake for 25-Year-Old Forest Equivalent

Alternative	Emissions Saved (lb CO_2 equiv./yd^3)	Annualized Emissions Saved (lb CO_2 equiv./yr)	Annualized Forest Equivalent (acres/yr)
Standard	120	1,796,646	1,021
EcoCrete 25%	150	2,246,252	1,276
EcoCrete 40%	227	3,405,482	1,935

Assuming an annual CO_2 uptake of 1,760 lb/yr for an acre of forest

Smaller Carbon Footprint -Volume of Gasoline Equivalent

Alternative	Emissions Saved (lb CO_2 equiv./yd^3)	Annualized Emissions Saved (lb CO_2 equiv./yr)	Annualized Volume of Gas Saved (gal/yr)
Standard	120	1,796,646	94,560
EcoCrete 25%	150	2,246,252	118,224
EcoCrete 40%	227	3,405,482	179,236

Assuming a 19 lb CO_2 emission for a gallon of gasoline

Acidification Potential - AC Units Equivalent

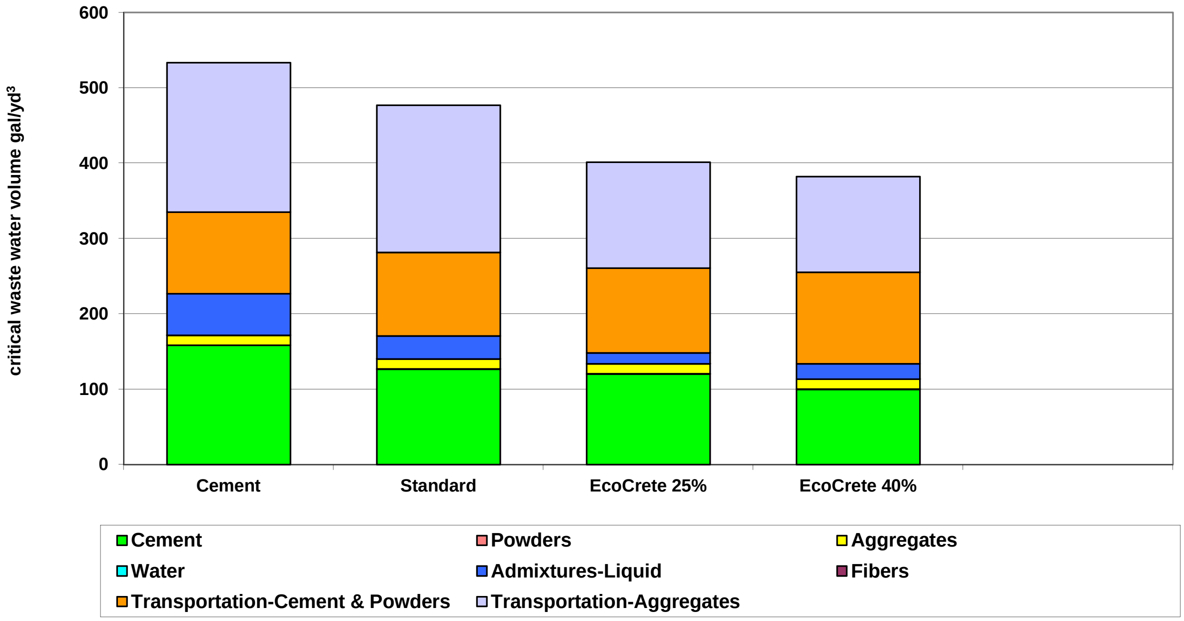
Alternative	Emissions Saved (lb SO_2 equiv./yd^3)	Annualized Emissions Saved (lb SO_2 equiv./yr)	Annualized AC Unit Equivalent (number/yr)
Standard	0.77	11,581	772
EcoCrete 25%	1.02	15,368	1,025
EcoCrete 40%	1.52	22,830	1,522

Assuming a 15 lb/yr SO_2 emission for an air-conditioning unit

Emissions – Water

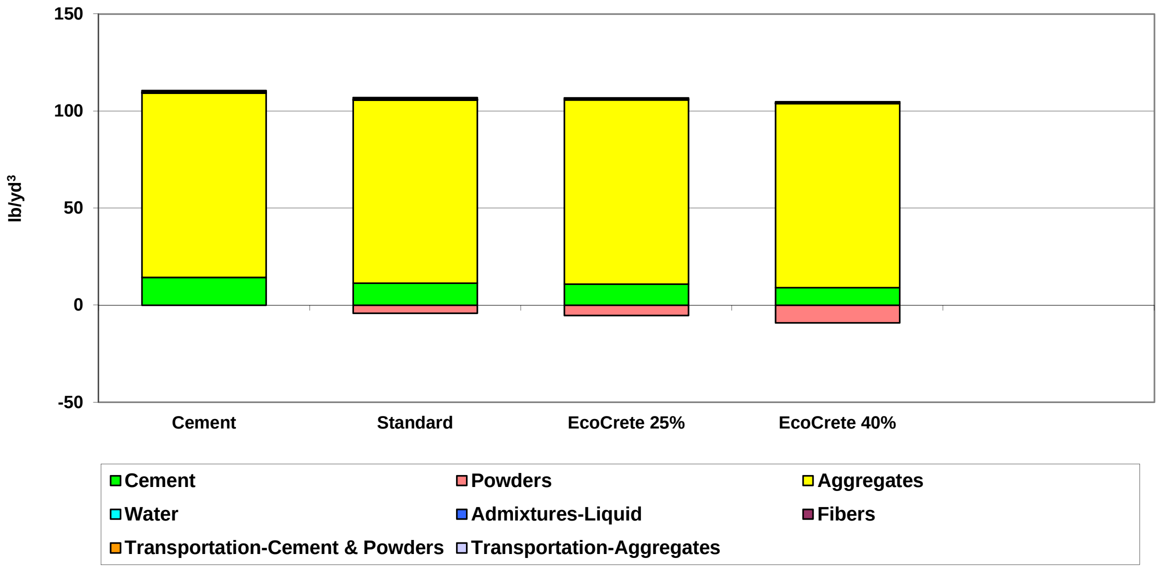
Water emissions are a measure of ecological toxicity potential and represent the amount of water needed to dilute the material to a non-toxic level. This value is dependent on the amount of material emitted and its toxicity level. The more harmful a substance is, the higher its critical waste water volume.

The data for this analysis is shown in the graph below.



Emissions – Solid Waste

Solid waste emissions account for all materials disposed of in a landfill. Materials that are recycled or reused are not considered solid waste. The data for this analysis is shown in the graph below.



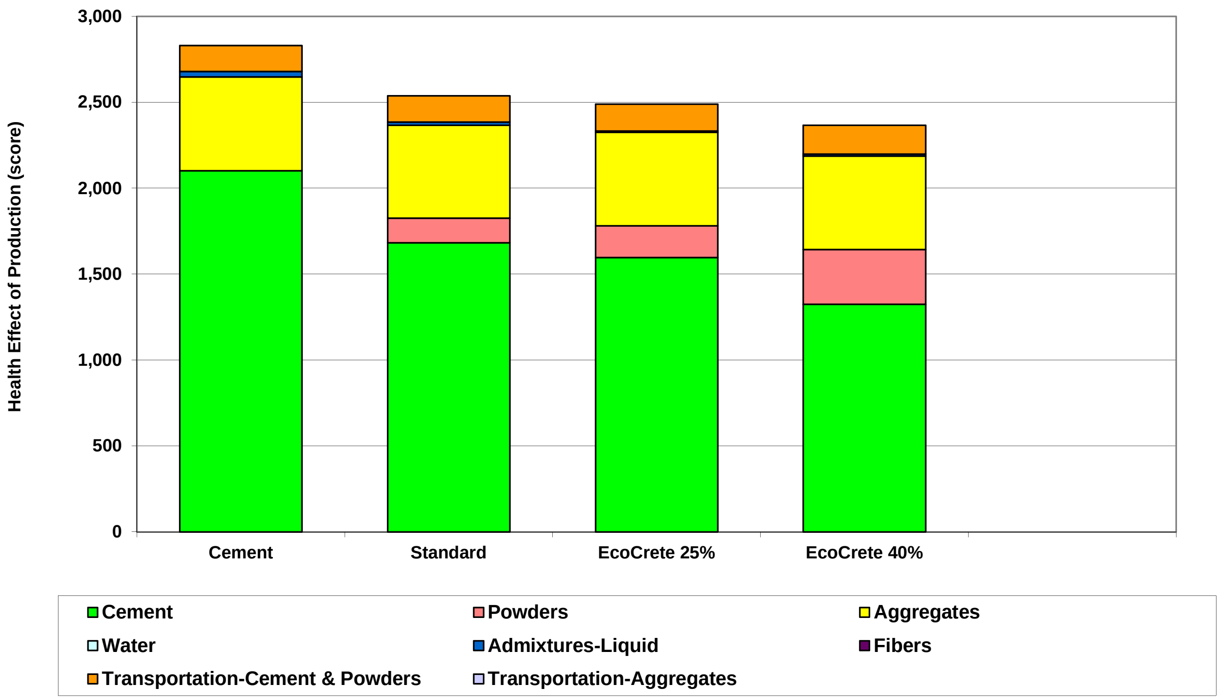
The table below quantifies the solid waste emissions, and a practical equivalent, saved by producing alternative concrete mixes relative to the reference benchmark.

Solid Waste Generation - Person Equivalent			
Alternative	Emissions Saved (lb/yd^3)	Annualized Emissions Saved (lb/yr)	Annualized Solid Waste Equivalent (Persons/yr)
Standard	7.8	117,230	23,446
EcoCrete 25%	9.1	135,758	27,152
EcoCrete 40%	14.8	222,596	44,519

Assuming 5 lb / day of solid waste is generated per person

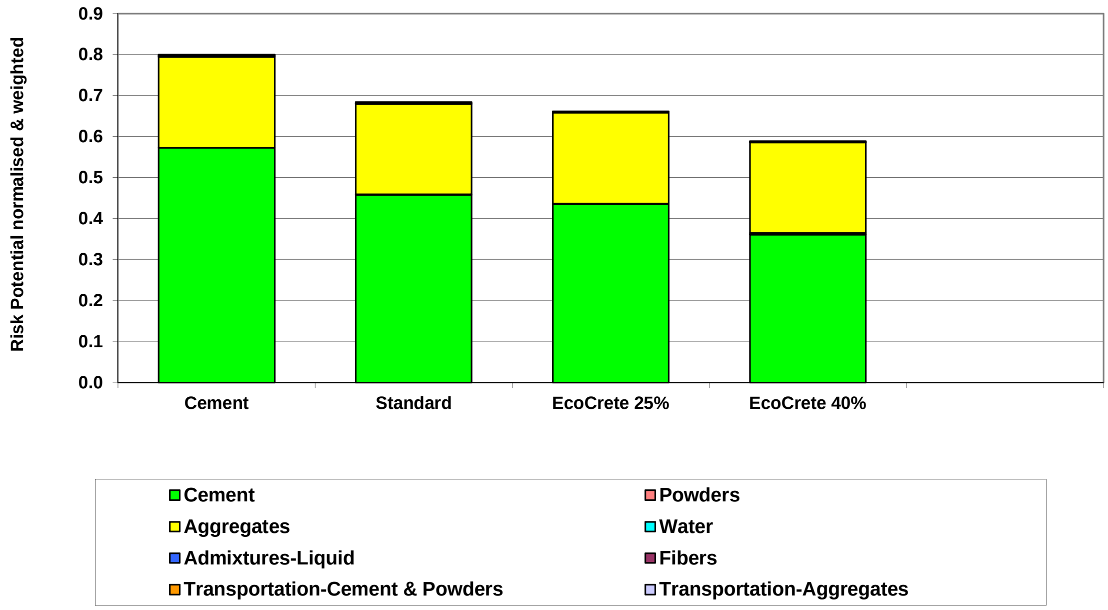
Toxicity Potential

The toxicity potential category focuses solely on the toxicity potential on human health. The toxicity potential focused on the production phase of the life-cycle only, since the use and disposal phases were equivalent. The graph below illustrates the individual and sum total toxicity potential for each concrete mixture analyzed.



Risk Potential

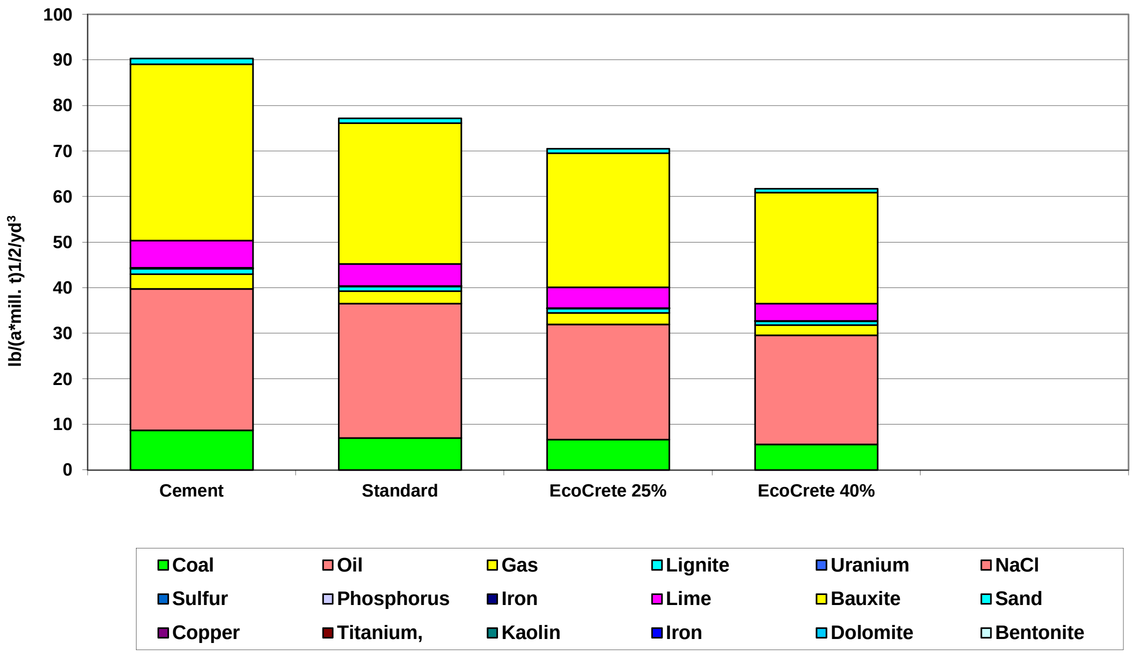
The Risk Potential section of the Eco-Efficiency Analysis considers all physical hazards (i.e. working accidents and occupational diseases) and is established using statistical data and expert judgement. Additional areas or risks that are considered include flammability, explosivity, storage and transportation risks. These numbers are normalized and weighted relative to the other alternatives and are not absolute values.



Raw Material Consumption

Raw material consumption considers all key materials consumed or produced to manufacture a unit volume of concrete. The individual quantities of each material are then weighted according to a factor that reflects the supply and available reserves for each raw material. The units on the table are the square root of the weight amount per annual million tons of the raw material consumed in the specific region being evaluated. It simple terms, it is the square root of the amount of the raw material used relative to the amount of the raw material used per year in a specific country or region.

The data for this analysis is shown in the graph below.



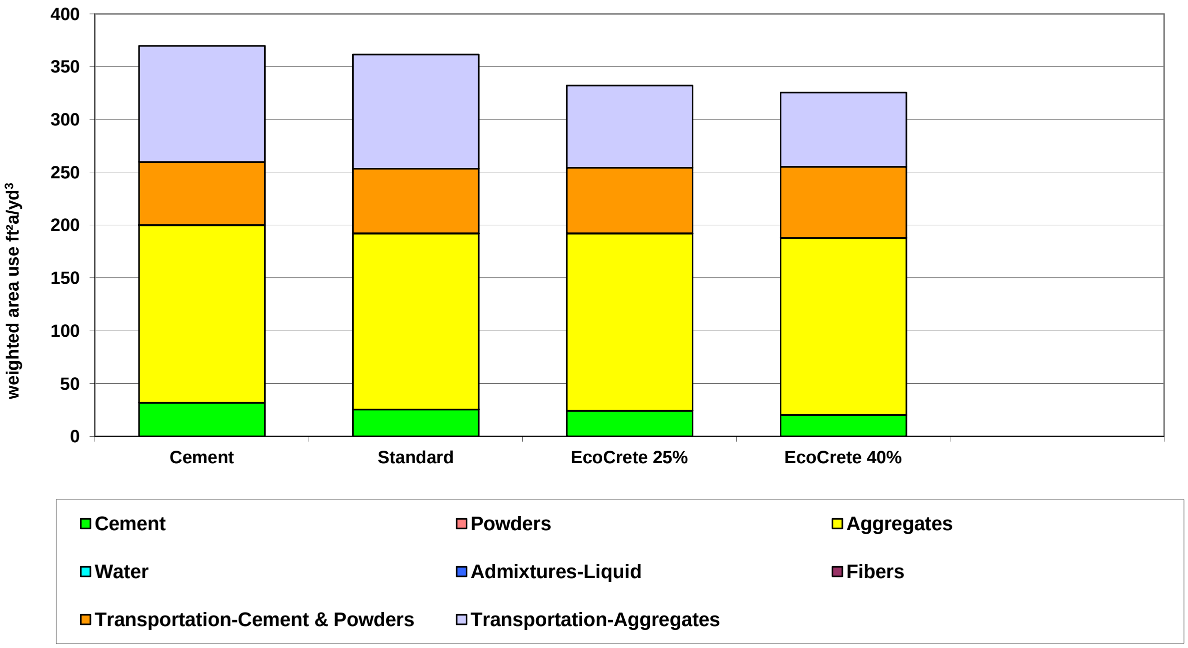
The table below indicates the savings of fossil fuel, and a practical equivalent, of the alternative concrete mixtures compared to the reference mix.

Fossil Fuel Consumption - Barrels of Oil Equivalent				
Alternative	Fossil Fuel Saved (lb/yd^3)	Annualized Fossil Fuel Saved (lb/yr)	Barrels of Oil Saved (number/yd^3)	Annualized Barrels of Oil Saved (number/yr)
Standard	8.7	129,815	0.1	1,725
EcoCrete 25%	19.3	290,151	0.2	3,245
EcoCrete 40%	25.5	382,357	0.3	4,425

Land Use

Land area is not consumed like a raw material. Depending on the type, scope and intensity of the use, land can be changed so radically that it is impaired or even destroyed in its ability to perform its natural function. In addition to the direct loss of fertile soil, subsequent effects also include diminishing the functionality of the ecosystem.

The degree of land development needed to produce a unit volume of concrete is considered for each concrete mixture. The chart below indicates the relative differences in land (area) use for each concrete mixture.



Validation

This Eco-Efficiency analysis was performed by BASF according to the methodology validated by NSF International under the requirements of Protocol 352, Part A. More information on BASF's methodology and the NSF validation can be obtainied at http://www.nsf.org/info/eco_efficiency/

Data acquisition and calculations used in BASF's EEA are in accordance with ISO standards 14040 and 14044 for life cycle assessment. The methodology has been thrid party validated by TUV and NSF International.

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NSF International – NSF Protocol P352 Validation and Verification of Eco-efficiency Analysis.

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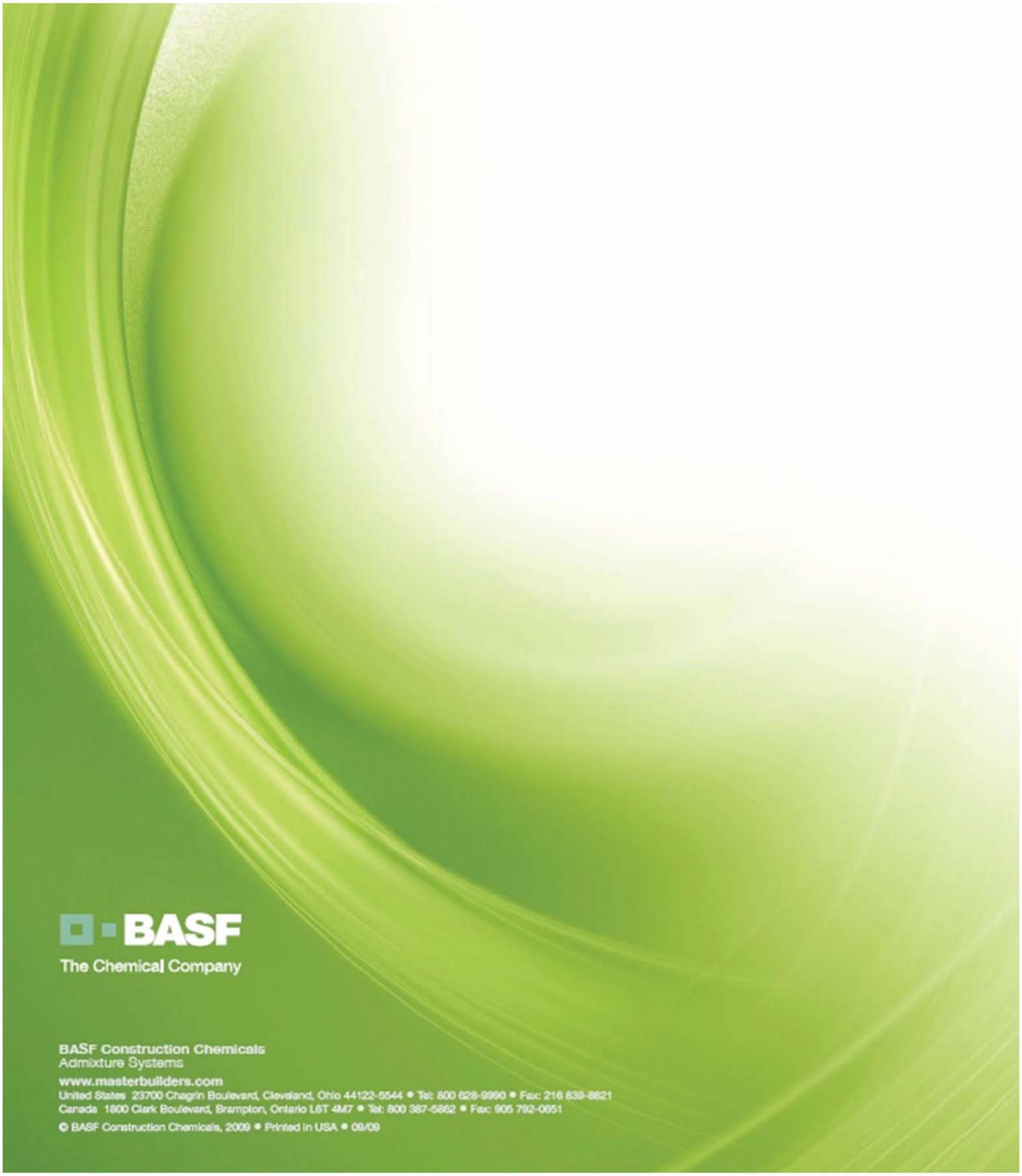

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