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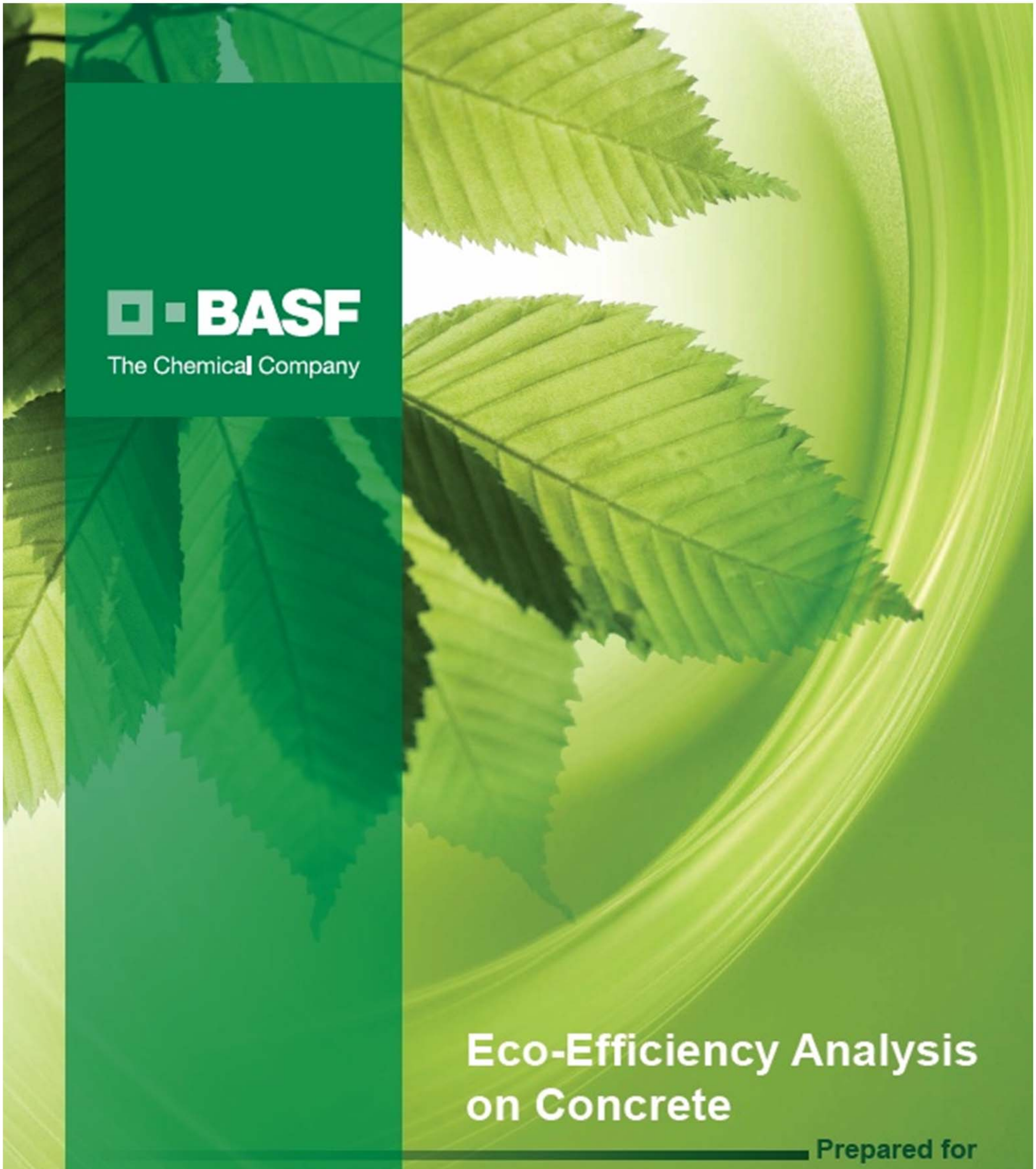


Mix Optimization 3,500 psi air
Allied Concrete Company
Charlottesville, VA

"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.

Consumption of Energy	Emissions	Toxicity Potential	Risk Potential	Consumption of Raw Materials	Land Use
• Cumulative energy utilized in the cradle-to-gate analysis • Fossil and renewable resources are included	• Described by categories - Air - Water - Solids	• Potential effect on human health toxicity	• Potential for physical hazard (accident and occupational disease) • Based on published statistical data	• Materials are weighted according to reserves and global consumption	• Degree of land development needed to fulfill the production of concrete

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:

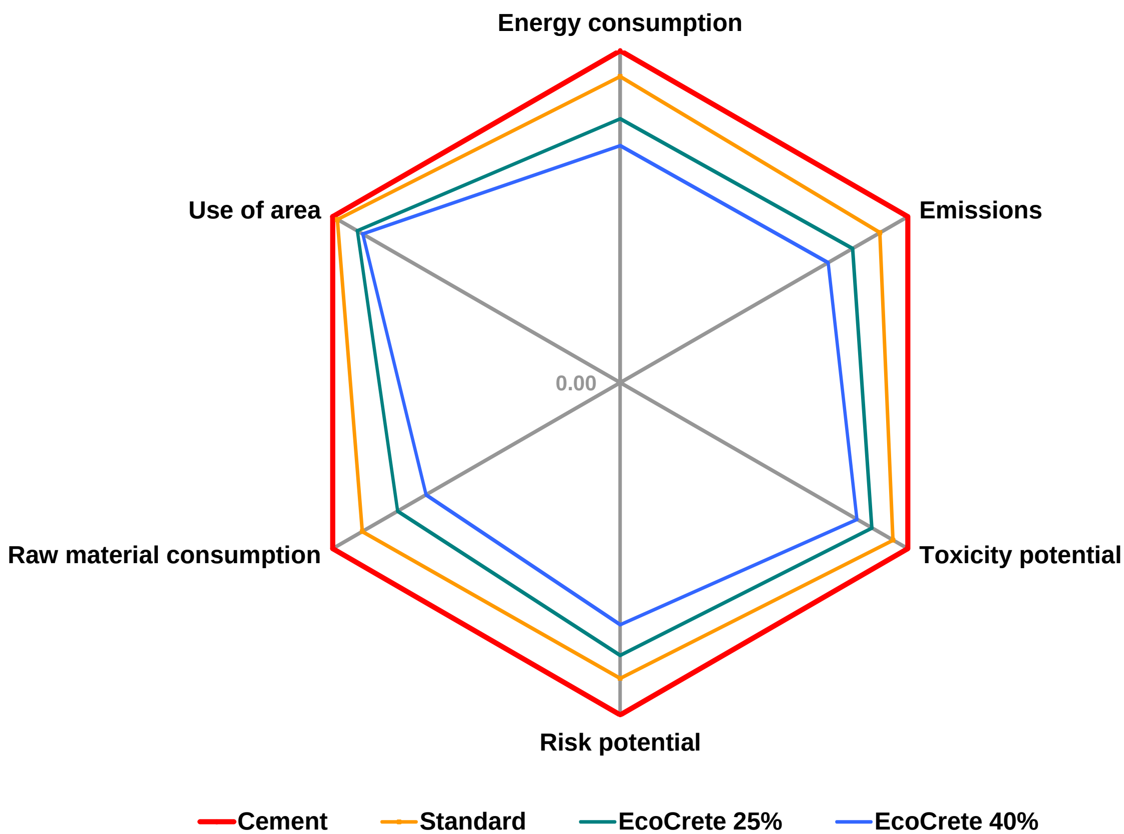
Concrete Volume (yd^3)	15,000
# of plants	1
Total Volume (yd^3)	15,000

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)	860	793	683	614
Res. Consumption (lb/yd^3)	93	84	72	63
Fossil Fuel Consumption (lb/yd^3)	45	42	36	33
GHG (lbCO$_2$eq/yd^3)	679	589	515	434
POCP (lbEthene eq/yd^3)	0.182	0.171	0.146	0.134
AP (lbSO$_2$eq/yd^3)	4.7	4.2	3.6	3.1
Water emissions (gal/yd^3)	515	496	414	390
Solid Waste (lb/yd^3)	109	100	102	96
Land Use (ft^2/yd^3)	366	360	335	328

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)	860	7.8%	20.5%	28.6%
Res. Consumption (lb/yd^3)	93	10.4%	22.6%	32.5%
Fossil Fuel Consumption (lb/yd^3)	45	5.9%	19.4%	26.2%
GHG (lbCO$_2$eq/yd^3)	679	13.3%	24.2%	36.1%
POCP (lbEthene eq/yd^3)	0.182	5.8%	19.4%	26.1%
AP (lbSO$_2$eq/yd^3)	4.7	12.0%	23.3%	34.4%
Water emissions (gal/yd^3)	515	3.6%	19.5%	24.2%
Solid Waste (lb/yd^3)	109	8.1%	6.9%	11.7%
Land Use (ft^2/yd^3)	366	1.7%	8.5%	10.4%

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%	3.36	50,326	224	380,966
EcoCrete 40%	5.16	77,361	344	585,626

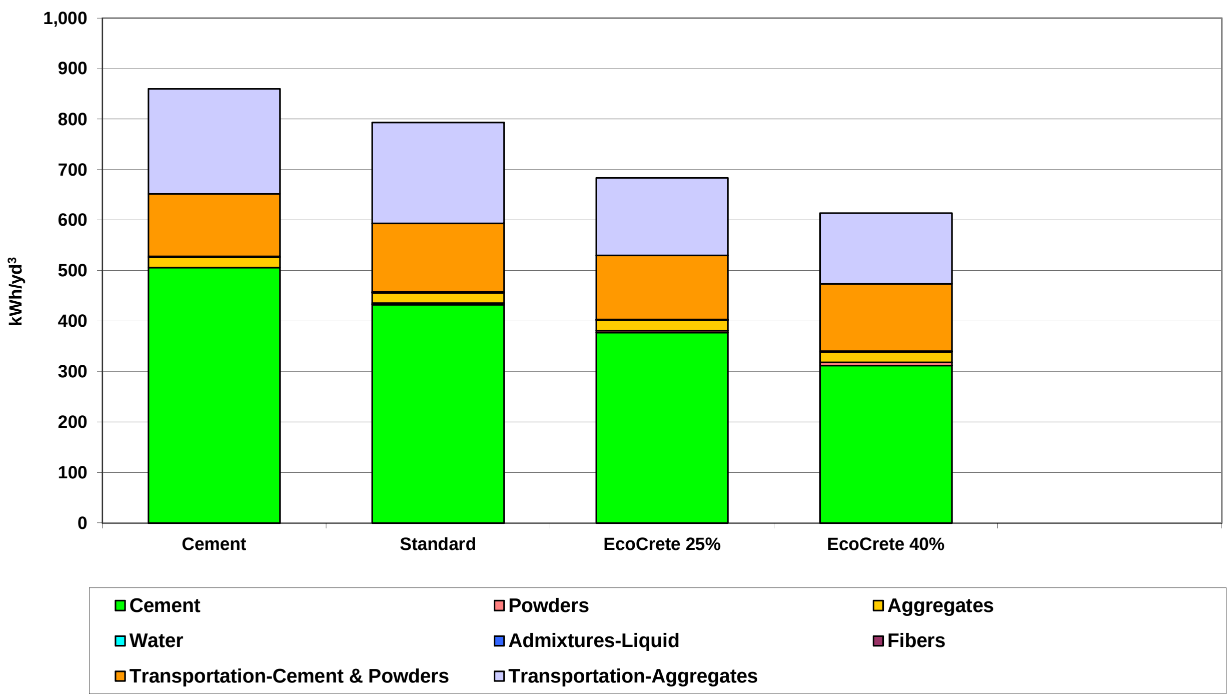
Assuming water required for washout is 225 gal/truck

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%	28.0	419,415	1,256	4,021
EcoCrete 40%	43.0	644,730	1,931	6,181

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	67	1,002,635	87
EcoCrete 25%	177	2,650,475	229
EcoCrete 40%	246	3,690,138	319

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

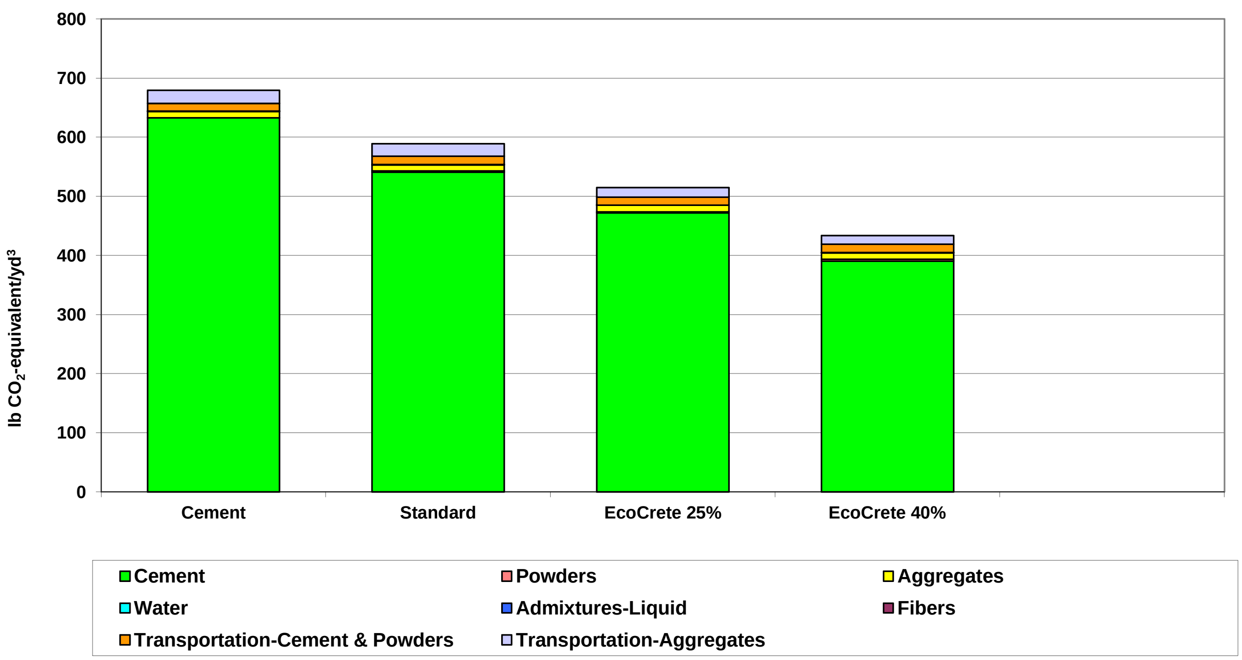
Emissions – Air

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



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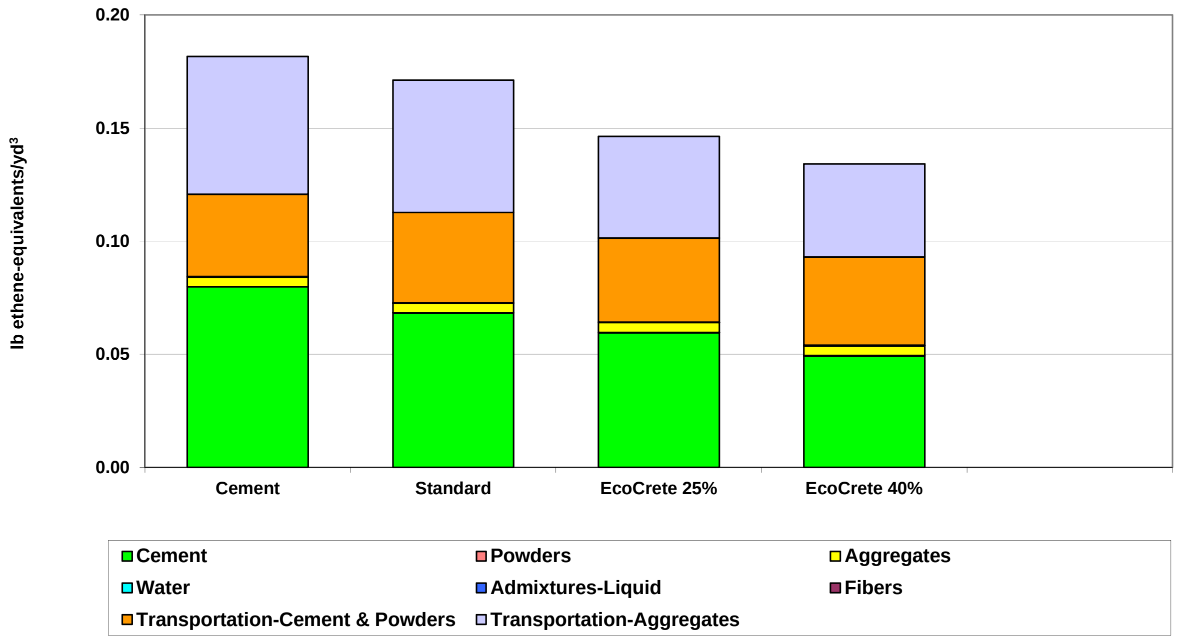
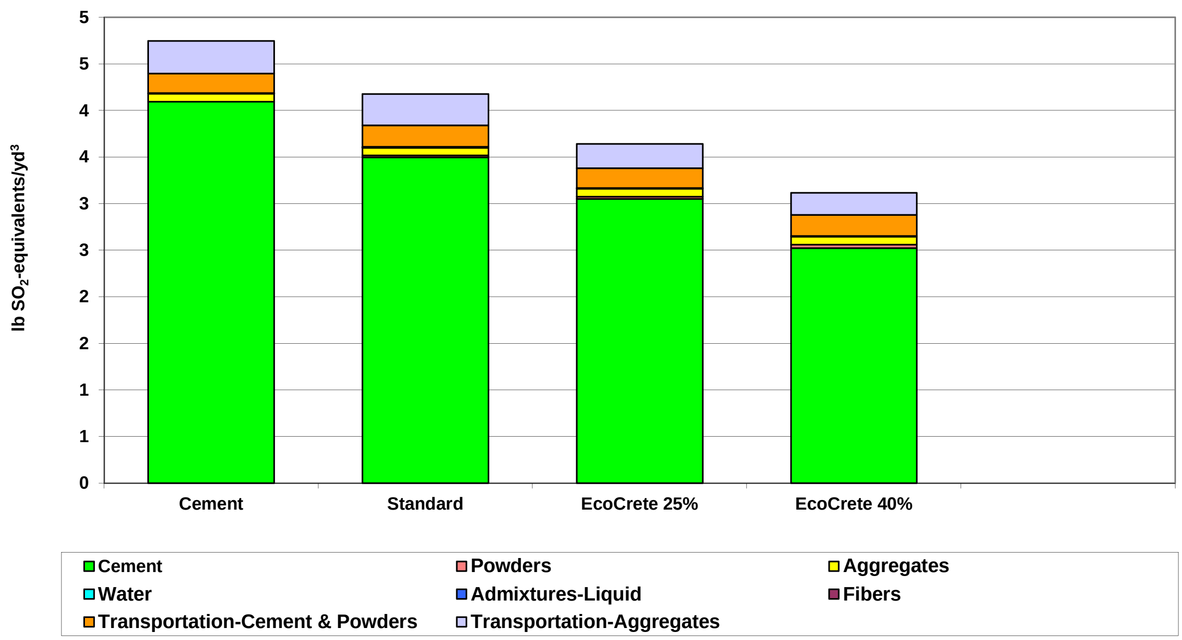
Emissions – Air (cont.)

Photochemical Ozone Creation Potential (POCP - Summer Smog)



Acidification Potential (Acid Rain)



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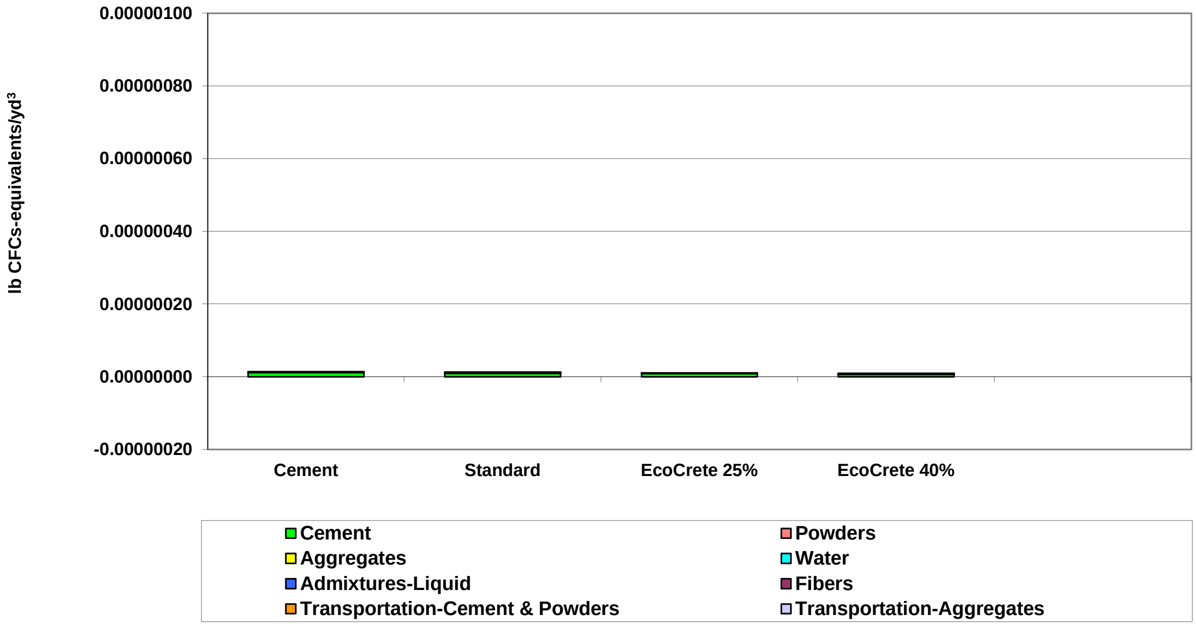
Emissions – Air (cont.)

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	90	1,351,458	768
EcoCrete 25%	164	2,467,066	1,402
EcoCrete 40%	246	3,682,626	2,092

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	90	1,351,458	71,129
EcoCrete 25%	164	2,467,066	129,846
EcoCrete 40%	246	3,682,626	193,822

Assuming a 19 lb CO_2 emission for a gallon of gasoline

Acidification Potential - AC Units Equivalent

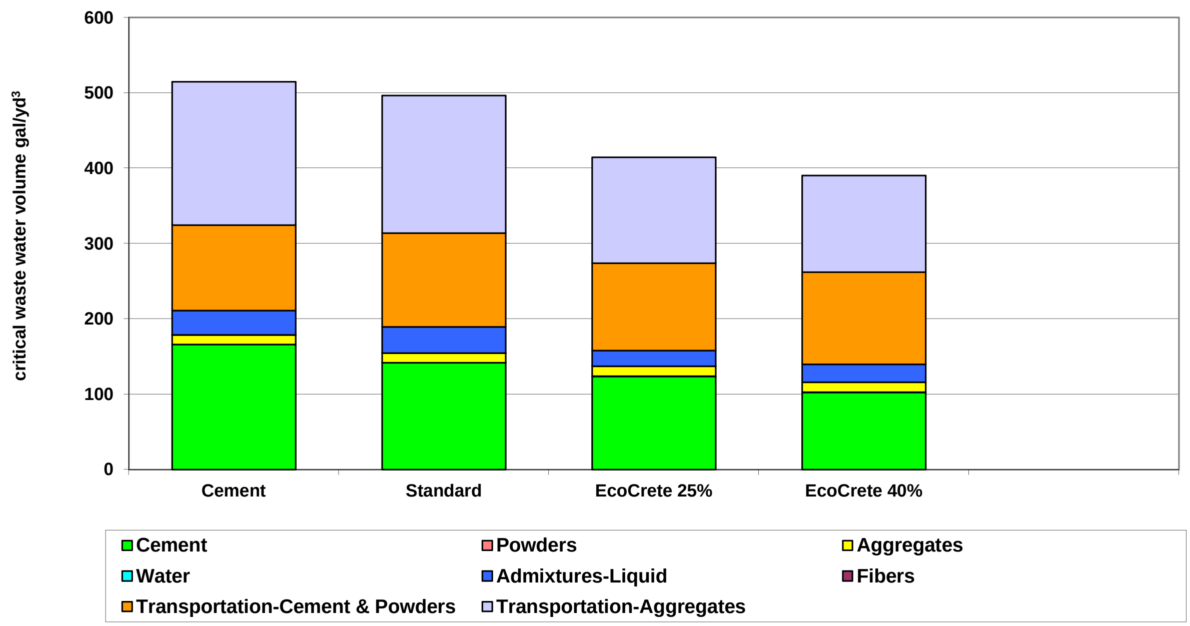
Alternative	Emissions Saved (lb SO_2 equiv./yd^3)	Annualized Emissions Saved (lb SO_2 equiv./yr)	Annualized AC Unit Equivalent (number/yr)
Standard	0.57	8,561	571
EcoCrete 25%	1.11	16,614	1,108
EcoCrete 40%	1.63	24,481	1,632

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

Emissions – Water

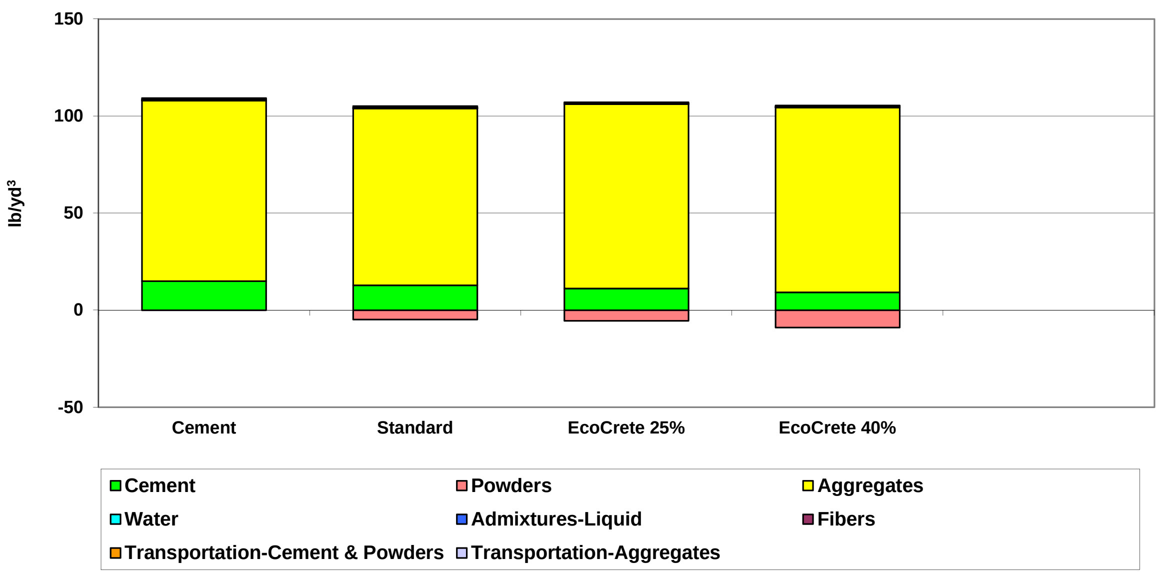
Water emissions are a measure of ecological toxicity potential and represent the amount of water needed to dilute the material to a non-toxic level. This value is dependent on the amount of material emitted and its toxicity level. The more harmful a substance is, the higher its critical waste water volume.

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.



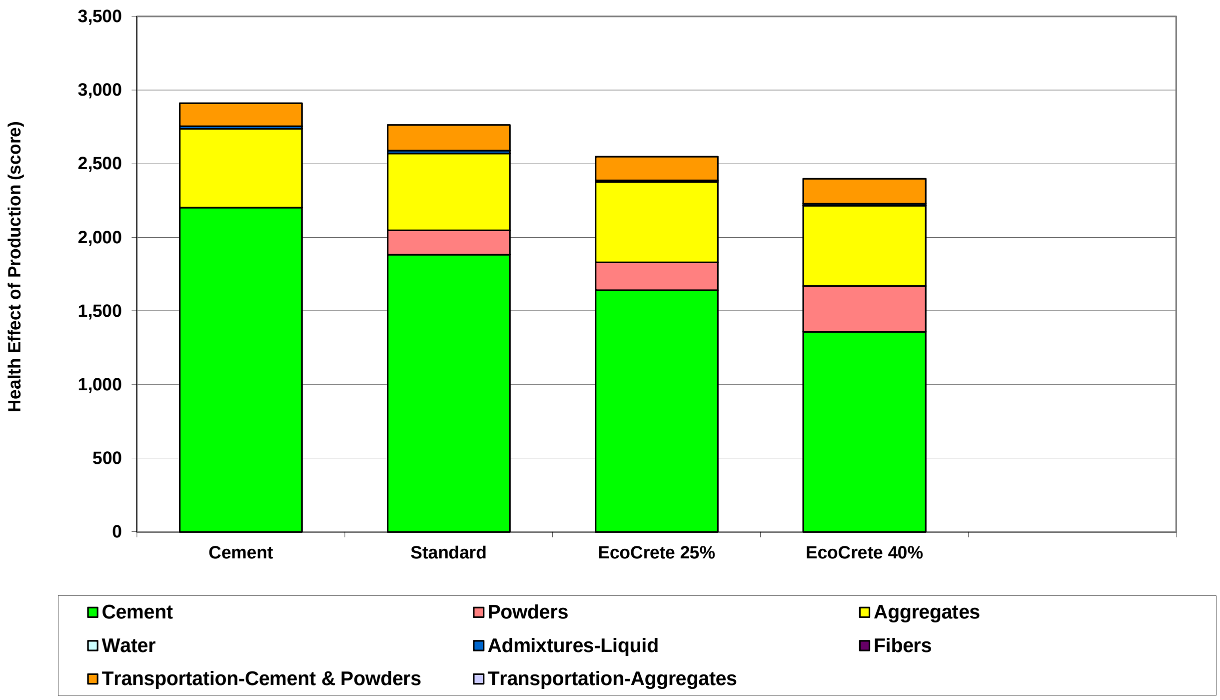
The table below quantifies the solid waste emissions, and a practical equivalent, saved by producing alternative concrete mixes relative to the reference benchmark.

Solid Waste Generation - Person Equivalent			
Alternative	Emissions Saved (lb/yd^3)	Annualized Emissions Saved (lb/yr)	Annualized Solid Waste Equivalent (Persons/yr)
Standard	8.8	132,383	26,477
EcoCrete 25%	7.5	113,086	22,617
EcoCrete 40%	12.8	191,356	38,271

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

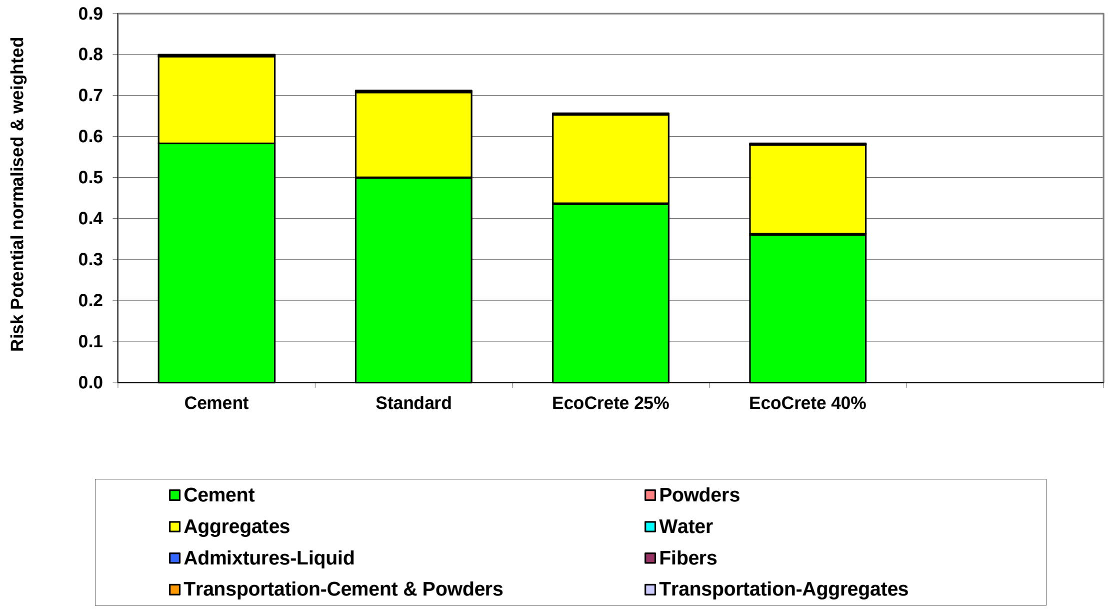
Toxicity Potential

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

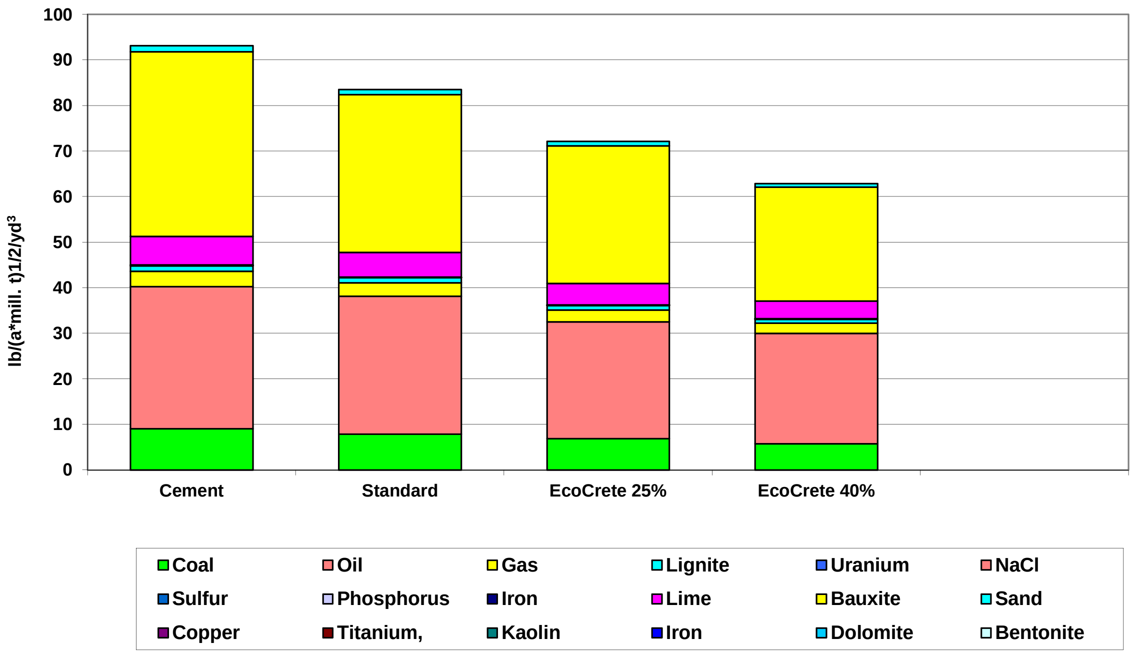
The Risk Potential section of the Eco-Efficiency Analysis considers all physical hazards (i.e. working accidents and occupational diseases) and is established using statistical data and expert judgement. Additional areas or risks that are considered include flammability, explosivity, storage and transportation 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.



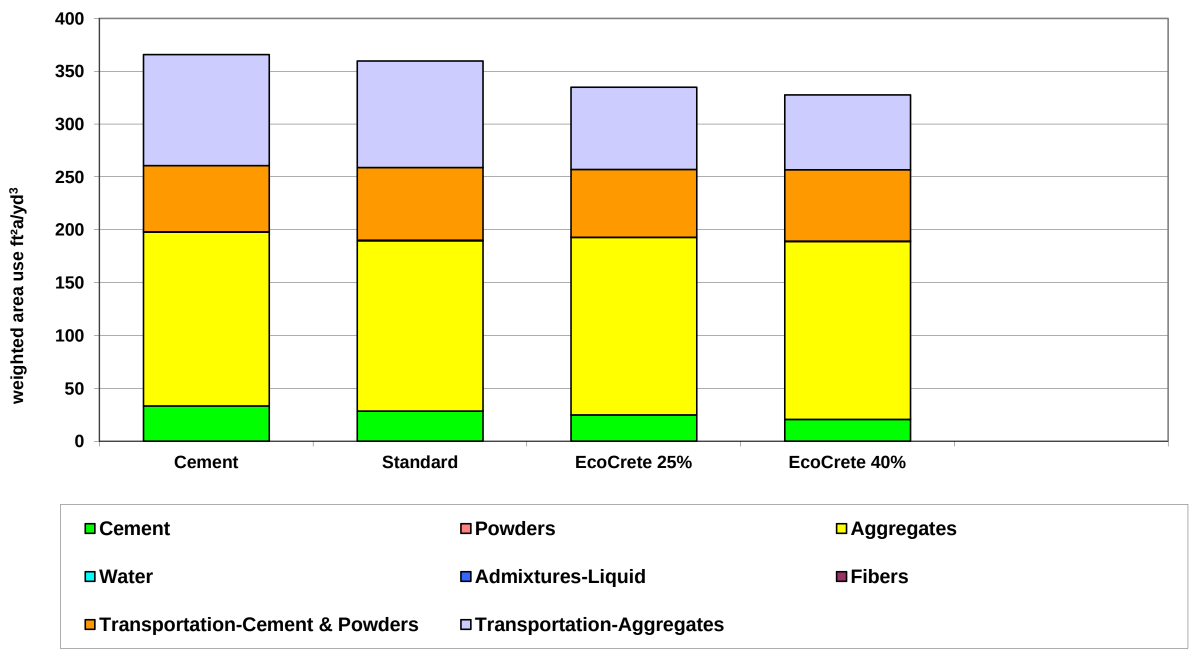
The table below indicates the savings of fossil fuel, and a practical equivalent, of the alternative concrete mixtures compared to the reference mix.

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	5.8	86,837	0.1	1,199
EcoCrete 25%	19.2	288,087	0.2	3,302
EcoCrete 40%	25.9	388,026	0.3	4,568

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.

ISO (International Organization for Standardization) is the world's largest developer and publisher of International Standards. ISO, is an international-standard-setting body composed of representatives from various national standards organizations. The organization promulgates worldwide proprietary industrial and commercial standards. ISO is a non-governmental organization, whose standards often become law and an organization that forms a bridge between the public and private sectors.

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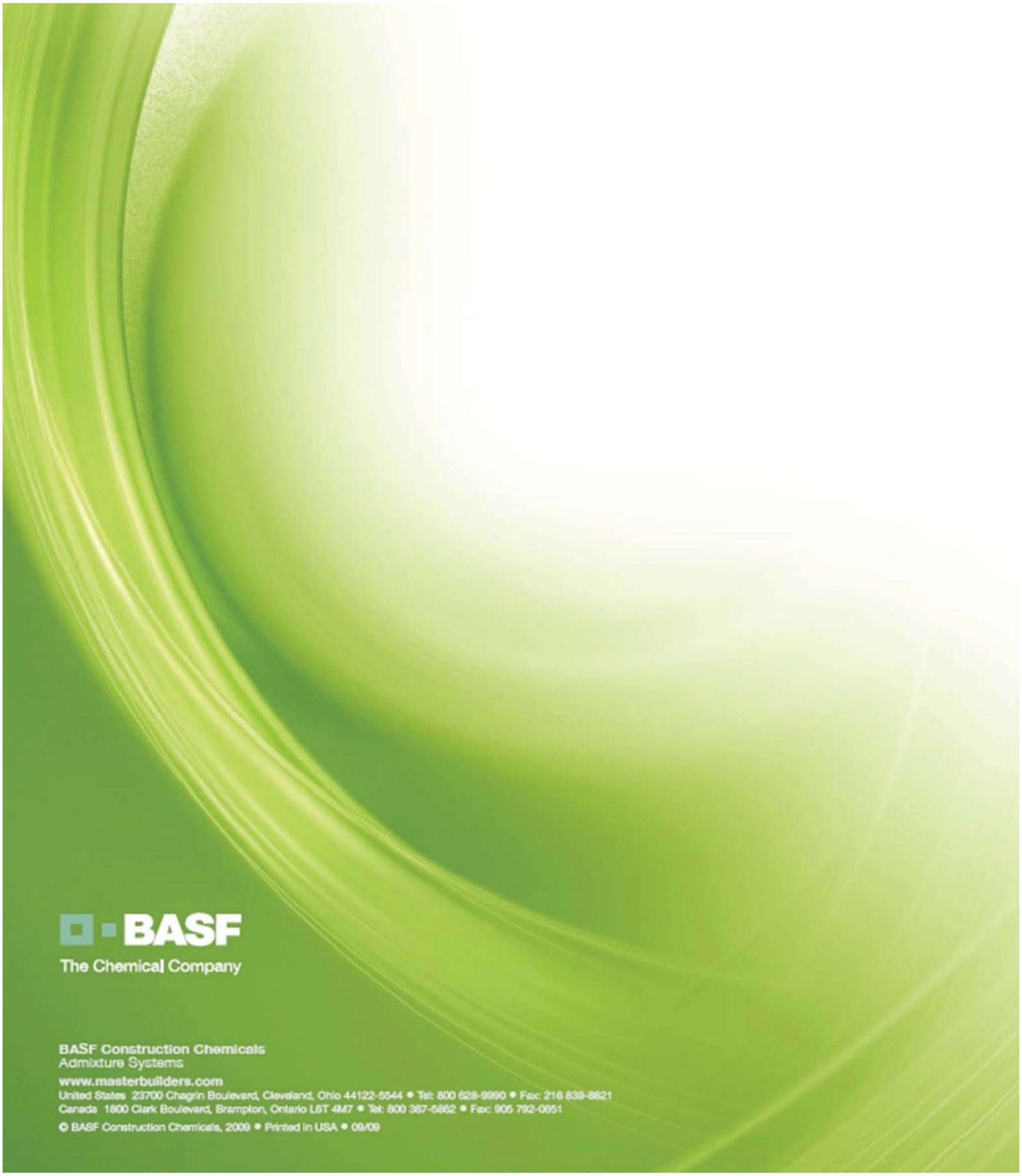
TUV appraises, tests and certifies technical equipment and products according to international quality standards and then registers those in compliance.

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

NSF International, a not-for-profit, non-governmental organization, develops national standards and provides third-party conformity assessment services.

The Admixture Systems business of BASF Construction Chemicals is a leading provider of innovative admixtures for specialty concrete used in the ready-mixed, precast, manufactured concrete products, underground construction and paving markets throughout the North American region. The Company's respected Master Builders brand products are used to improve the placing, pumping, finishing, appearance and performance characteristics of concrete.



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