ADMIXTURES – ESSENTIAL INGREDIENTS OF 21ST CENTURY

NIHAL KINNERSLEY

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EFCA - Environmental Committee Chair

GCP Applied Technologies - Product Stewardship Manager EMEA

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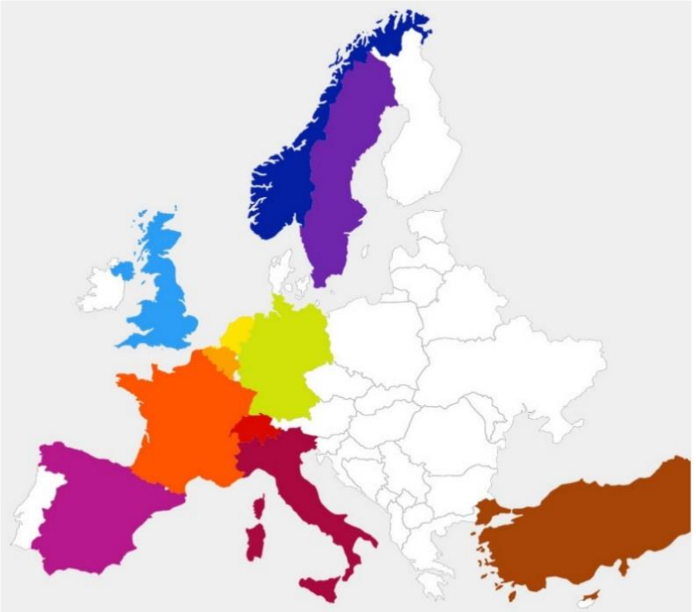
EFCA – European Federation of Concrete Admixtures Associations

EFCA was formed in 1984 as a partnership between National Admixture Associations in order to promote the interests of the industry at European level.

There are currently 11 National Association members of EFCA.



EFCA – Cooperation with Key European Organisations

European Commission

EFCA is working on committees and in expert groups covering:

- Mandate M/136 the European Acceptance Scheme for Construction Products in Contact with Drinking Water.
- Mandate M/366 on Regulated Dangerous Substances.
- Regulation (EU) No 305/2011 the Construction Products Regulation (CPR).
- Regulation (EC) No 1907/2006 – REACH and Regulation (EC) No 1272/2008 – the Classification, Labelling and Packaging of substances and mixtures (CLP).
- EFCA is an Approved Stakeholder to the European Chemical Agency (ECHA).

European Standardisation

- EFCA was instrumental in the development of European admixture standards (EN 934 standards series) and test methods for concrete (EN 480 standards series).
- Most concrete admixtures conform to the requirements of EN 934 and are in use by the National Standards Bodies of 31 European countries.
- EFCA members continue to work with CEN/TC 104/SC3 to maintain and improve the concrete admixtures standards and test methods.
- EFCA has been granted Liaison Organization status by CEN.

Environmental

- In 2015 EFCA is updating its previous Environmental Product Declarations (EPD) by publishing Model European EPD for six admixture types. These will be verified by the Institute of Construction and Environment e.V. (IBU), a member of the ECOPlatform, to be in compliance with EN 15804 and EN ISO 14025. Copies of the EPD will be available at the EFCA website www.efca.info
- Through the European Concrete Platform EFCA is involved directly in the development of the Concrete Sustainability Council Responsible Sourcing Scheme for Concrete.

EFCA - Strategic Links

ECP – The European Concrete Platform

CPE – Construction Products Europe

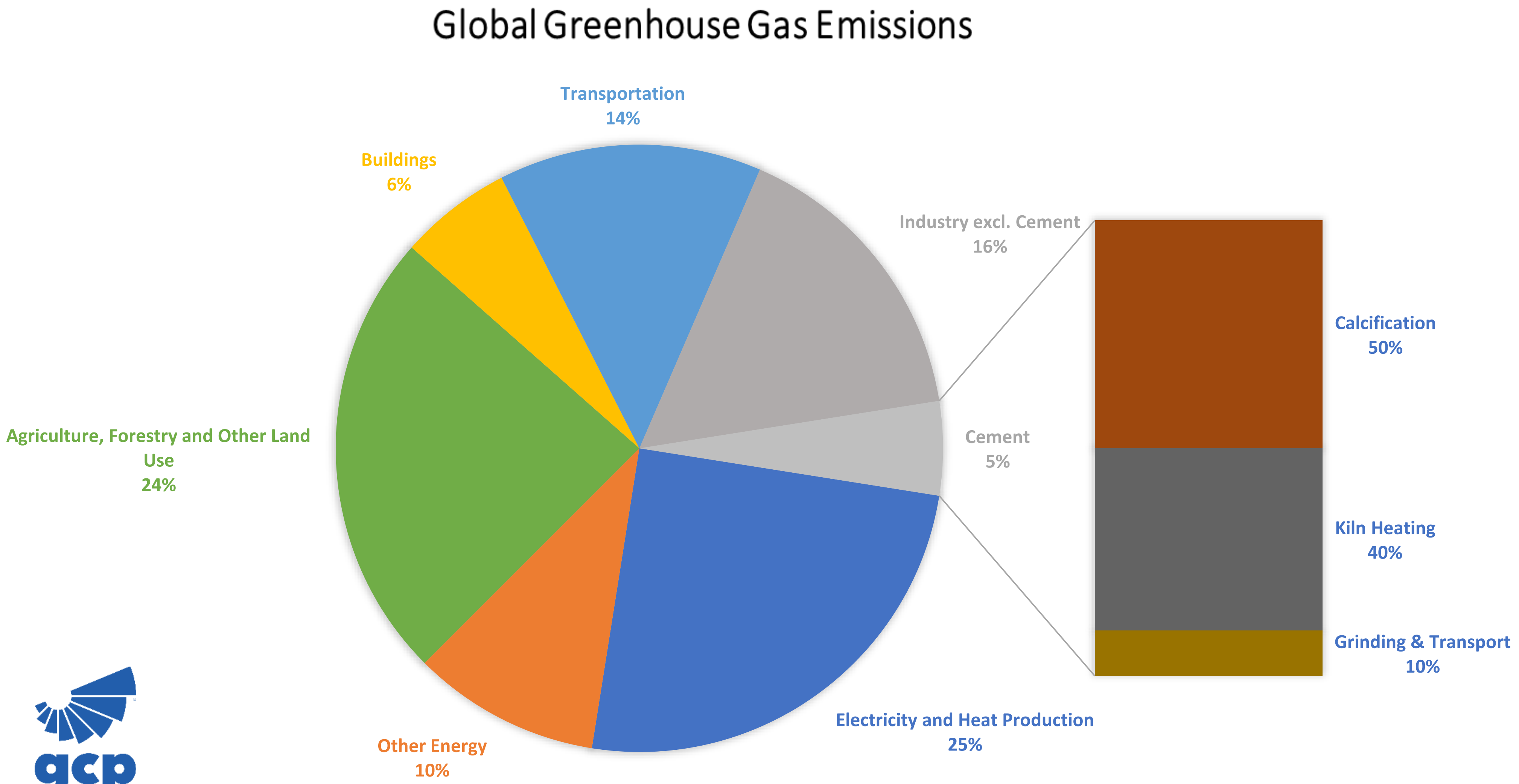
Cembureau – The European Cement Association

ERMCO – The European Ready Mixed Concrete Organization

BIBM – The European Federation for Precast Concrete

European Chemcials Association

Admixtures – Essential Ingredients of 21st Century



Industry and Cement production

Cement is the world's most widespread manmade material, with approximately 0.56 tonnes produced annually for every person on Earth.

Cement manufacturing produces 0.7-1.0 tonne of CO2 emissions per tonne of cement, and accounts for approximately 5% of all global greenhouse gas emissions – making it among the largest contributors of greenhouse gases on the planet.

The production of cement clinker is the largest emitter of CO_2 outside the energy sector, accounting for about 5% of global emissions.

Concrete Admixtures can help reduce this carbon footprint.

Cementitious materials are the world's most widespread manmade material, bringing opportunity to the industry to contribute to a greener future. Concrete admixtures are part of that opportunity, enabling the reduction in the amount of cement needed to achieve a given strength specification.

Admixtures – Essential Ingredients of 21st Century

Concrete Admixtures are formulated chemicals added to concrete at very low quantities (typically < 0.5 % by weight of cementitious material). Their primary function is to improve the properties of concrete, in its plastic and/or hardened states.

Water reducers and superplasticisers help disperse cement particles evenly, improving the flowability and workability properties of the concrete. With the use of admixtures, less amount of water is needed, resulting in concrete with a lower porosity and therefore a higher load-carrying capacity per unit of cement used.

For a given strength requirement, less cement is used, reducing the carbon footprint of the concrete. For Ready Mix Concrete, if fast setting times can be sacrificed when unnecessary, a reduction of CO2 emissions can lead to cost savings. Therefore, **it would be more economical to be more environmentally conscious**.

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Admixtures – Essential Ingredients of 21st Century

Conventional concrete is widely used in building projects because it's easy to produce and deliver to the jobsite and it's resistant to small variations in water content.

Large crews are normally needed to properly place and finish conventional concrete, and this presents increasing challenges as labour markets tighten.

The current drive to sustainable building practices is also presenting the construction industry with a challenge, and an opportunity.

Self-compacting concrete (SCC) has proven itself as a viable alternative for some applications. Its high flowability, excellent passing ability, and self-leveling characteristics make it very easy to place, with minimal labor requirements.

It is more expensive to produce due to the specialised mixture designs, high powder contents, and the extra quality control efforts required to minimize batch-to-batch moisture variability.

High cement levels also lead to a high CO_2 footprint.

Admixtures – Essential Ingredients of 21st Century

Concrete admixtures contribute to the reduction of CO_2 emissions from cementitious materials in three ways:

(1) a reduction of cement used,

(2) a reduction of mixing and/or placement energy, and

(3) an increase in longevity of the concrete structure.

Control Flow Concrete combines the first two approaches – a reduction in cement content for easy-to-place concrete and a reduction of placement energy.

Control flow concrete, a new category of highly flowable concrete, has distinct **rheological behaviour** compared to conventional concrete and SCC. The highly flowable concrete is enabled by control flow concrete admixtures, which work with conventional mixtures, with relatively low cement factors, reducing the CO_2 footprint of flowable concrete compared to SCC.

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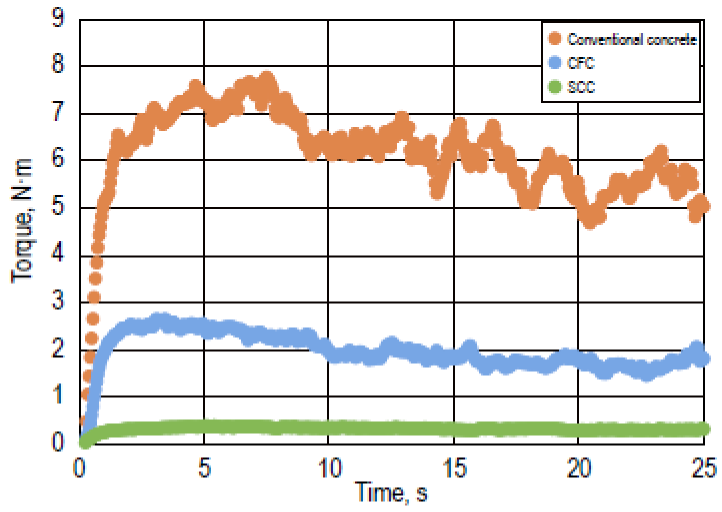
Control flow concrete admixtures enable the production of highly flowable concrete using mixture proportions typical of conventional concrete. Since there is no increase in the cement content, the **environmental footprint is the same**.

The highly flowable control flow concrete result in a static yield stress that is much lower than that of conventional concrete, allowing concrete to start flowing with minimal energy input. This type of concrete will not self-level like SCC, so it can be placed evenly on small grades, and it will also remain segregation-resistant over a reasonable variation in water content.



Raw data for static yield stress

The leading edge of control flow concrete at rest, during placement of a slab-on-ground

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Highly flowable control flow concrete bridges the gap between conventional concrete and SCC, offering significant improvements in quality, performance, and productivity for concrete producers and contractors alike. This type of concrete flows more readily but has the same stability or segregation resistance as conventional concrete.

Where conventional concrete requires vibration for consolidation, there is minimal need for vibration during placement of control flow concrete due to its high flow and high responsiveness to external energy.

	Conventional concrete	Control flow concrete	SCC
w/c*	0.50-0.55	0.42	0.40
Slump/Slump flow, mm	75-125	400 to 630	> 550
Admixture	superplasticiser	superplasticiser and proprietary admixture	superplasticiser

*water-cement ratio

Slump / Slump Flow Spread Comparison

Control Flow Concrete being placed in a flatwork application

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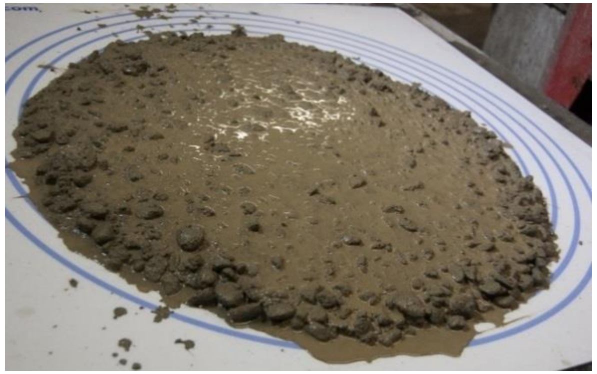
Admixtures – Essential Ingredients of 21st Century

Good slump flow and slump flow retention: In addition to superplasticisers required to disperse the cement particles and reduce the yield stress, good slump flow retention is also necessary for transportation and placement of the material.

High doses of superplasticisers can cause segregation when used in conventional concrete mixtures. The control flow concrete admixtures produce segregation-resistant concrete. These proprietary polycarboxylate admixtures provide good initial slump flow and slump flow retention without segregation.



(a)

(b)

The slump flow test is used to evaluate flowability and segregation resistance: (a) a conventional mixture overdosed with superplasticisers exhibits flow but also segregation; and (b) control flow concrete also exhibits flow, but no segregation

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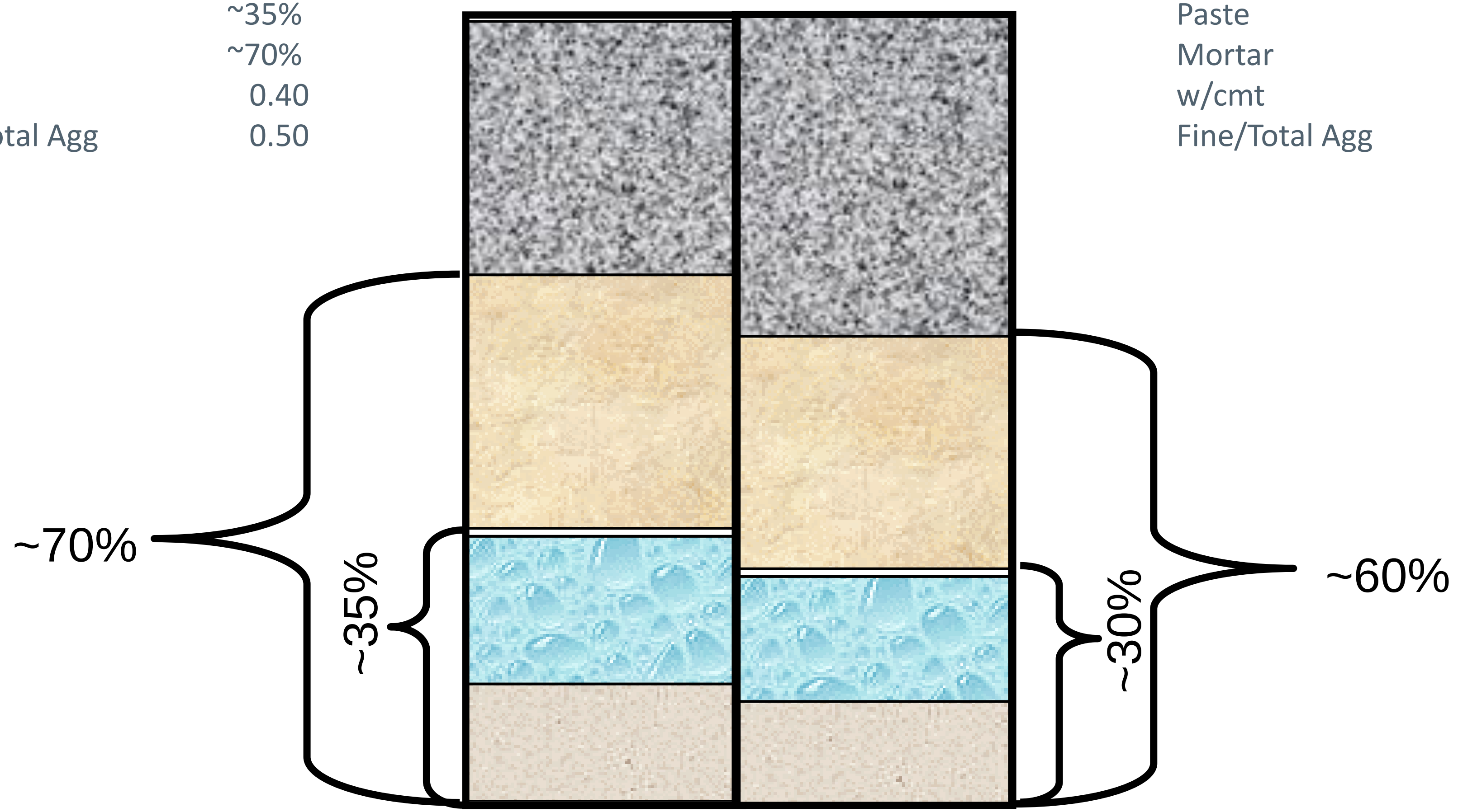
Economic value and Sustainability - Comparison of Concrete Mix Proportions

Self Compacting Concrete

Coarse Agg	~3/8”
Paste	~35%
Mortar	~70%
w/cmt	0.40
Fine/Total Agg	0.50

Control Flow Concrete

Coarse Agg	3/4”
Paste	~30%
Mortar	~60%
w/cmt	0.38
Fine/Total Agg	0.42



SCC Has Higher Percentage of Most Expensive Components

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Environmental benefits of using Admixtures

The flowability reduces the amount of energy needed to pump and place the concrete, providing an environmental benefit.

Highly flowable control flow concrete uses mix designs similar to conventional concrete, with larger aggregates and a lower cement factor.

The lower cement loading reduces the CO_2 footprint compared to other easy-to-place concretes such as self-compacting concrete

Type of Concrete	Cement factor (kg cement/m^3)	CO_2 footprint (kg CO_2/m^3)
Conventional concrete (180 mm slump)	362	300
Control flow concrete (460-560 mm slump-flow)	362	300
Self-compacting concrete (> 640 mm slump-flow)	512	424

Table summarizes CO_2 data relative to manufacture of each component

Summary

We have seen the general benefit to the sustainability that concrete admixtures bring to cementitious materials.

The pressures of minimising cost and environmental impact, accelerating construction schedules, reducing concrete placement labour, and improving concrete durability have combined to make admixture use necessary.

Frequently, several admixture technologies may be combined to ensure that a variety of performance specifications are met. Furthermore, the desire to reduce the environmental impact of cement clinker manufacture has also led to the use of multiple secondary cementitious materials (SCMs) having widely differing compositions, reactivities, surface areas, absorptive capacities and other factors.

Admixtures help maintain the desired performance characteristics of the SCM concrete systems, and thus substantially reduce the environmental footprint by enabling lower clinker factors.

As future pressure on sustainability will continue to require increasingly complex combinations of cementitious materials, likely with higher aluminum content and higher admixture use, it is important to develop a better understanding of how to predict and manage their collective behaviour.

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THANK YOU
FOR YOUR ATTENTION!

nihal.kinnersley@gcpat.com

Product Stewardship Manager EMEA
GCP Applied Technologies