CONCRETE
SUSTAINABLE SOLUTIONS
MORE VALUE LESS IMPACT

BUILDING TRUST

THE SIKA LIFE CYCLE APPROACH

WHAT IS LIFE CYCLE ASSESSMENT (LCA) AND WHY IS IT RELEVANT?
Life Cycle Assessment (LCA) is a standardized method to assess and compare the inputs, outputs and potential environmental impacts of products and services over their life cycle. LCA's are increasingly recognised as the best way to evaluate the sustainability of products and systems.

WHAT ARE THE STEPS TO PREPARE AN LCA?

Goal and scope definition	Defining the product system, functional unit, system boundaries, agreed assumptions and impact assessment methodology
Inventory analysis	Collection of the data required to quantify these relevant inputs and outputs of the product system
Impact assessment	Association of inventory data with impact categories
Interpretation	

WHAT CONCRETE RELATED IMPACT CATEGORIES AND RESOURCE INDICATORS ARE INCLUDED IN AN LCA?
As a standard approach, Sika evaluates all impact categories and resource indicators deemed as important according to the relevant standards. For concrete, categories considered to be most relevant include:

Cumulative Energy Demand (CED)
Cumulative Energy Demand (CED) accounts for the consumption of energy resources, namely the total amount of primary energy from renewable and non-renewable resources.

Global Warming Potential (GWP)
Global Warming Potential (GWP) measures the potential contribution to climate change, focusing on emissions of greenhouse gases, such as carbon dioxide (CO_2), which enhance the heat radiation absorption of the atmosphere, causing the temperature at the earth's surface to rise.

Use of Net Fresh Water
The use of net fresh water accounts for the consumption of fresh water (e.g., feed water, ground water, lake water, river water, surface water, water with river silt).

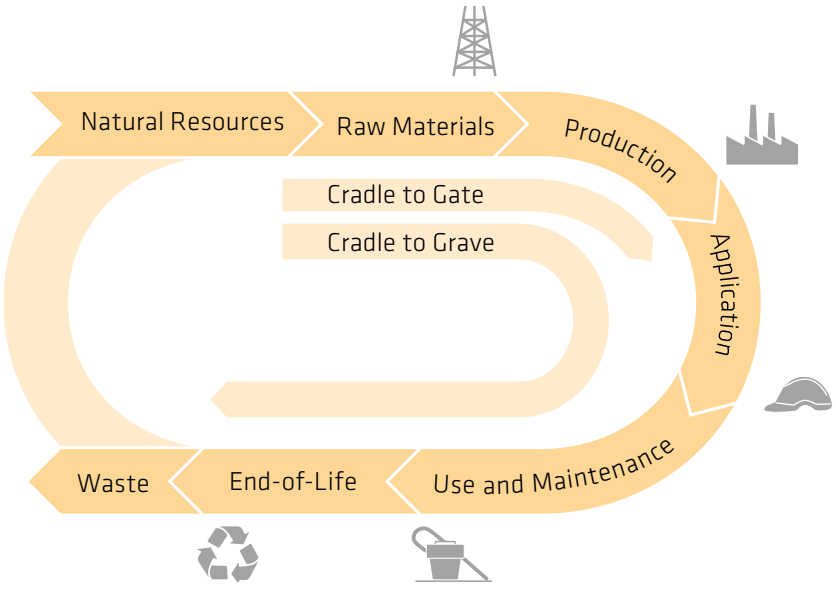
ON WHAT STANDARDS ARE SIKA LCA'S BASED?
Sika carries out LCA's according to the ISO 14040 series and the Standard EN 15804. The impact assessment methodology used is CML 2001.

WHERE DOES THE SIKA LCA DATA COME FROM?
The data for the Sika LCA is based on public databases, such as those from Ecoinvent, the European Reference Life Cycle Database (ELCD) and Thinkstep-GaBi, plus the specific data from Sika production plants and products.

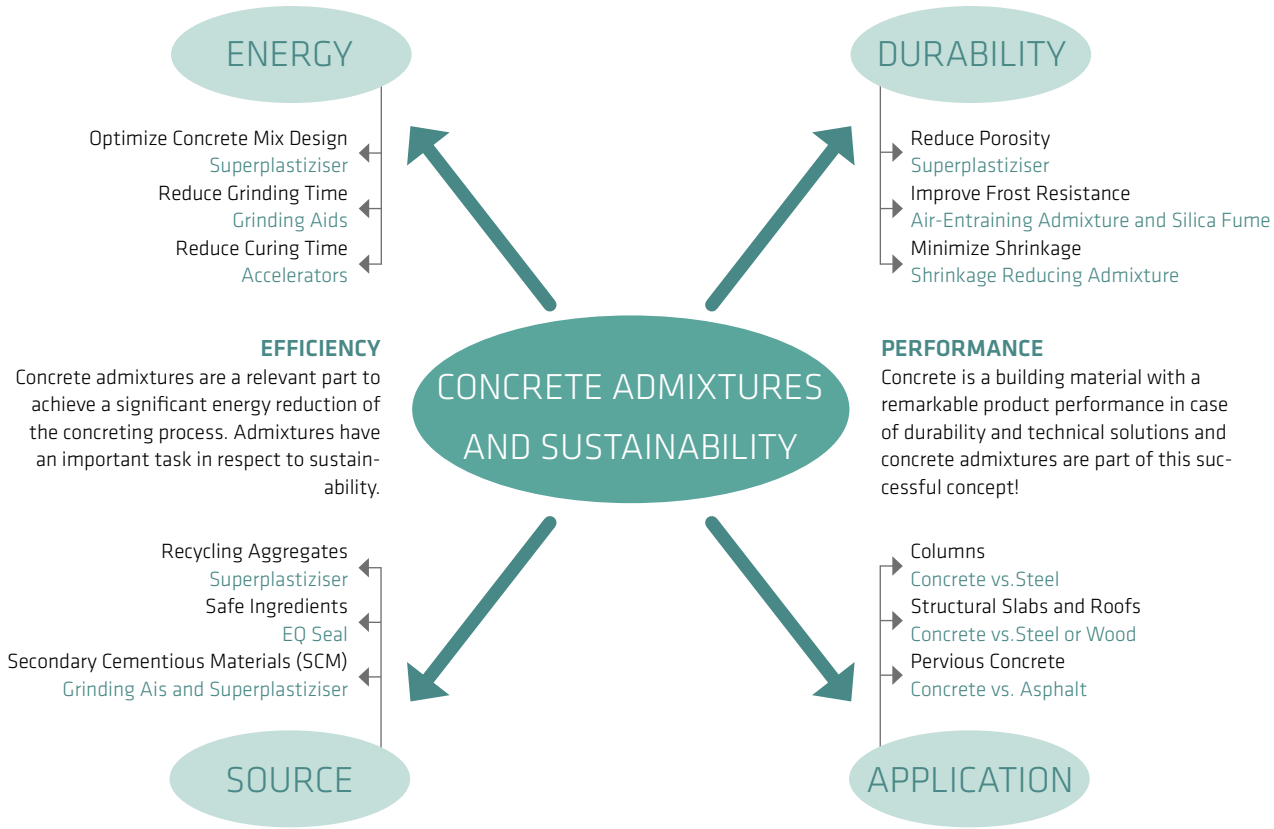
WHAT DOES 'CRADLE TO GATE' MEAN?
In a 'Cradle to Gate' approach, the LCA investigates the potential environmental impact of a product from raw material extraction to finished production.

WHAT DOES 'CRADLE TO GRAVE' MEAN?
In a 'Cradle to Grave' approach, the LCA investigates the potential environmental impact of a product from raw material extraction, production, application and use to final disposal at the end-of-life.

WHICH LIFE CYCLE PHASES ARE INCLUDED IN THESE SIKA LCA'S?
The LCA data in this brochure refers to 1 m^3 of concrete and is based on a 'Cradle to Gate' approach.



SIKA SUSTAINABILITY PERFORMANCE-EFFICENCY APPROACH



LCA RESULTS FOR CONCRETE TYPES

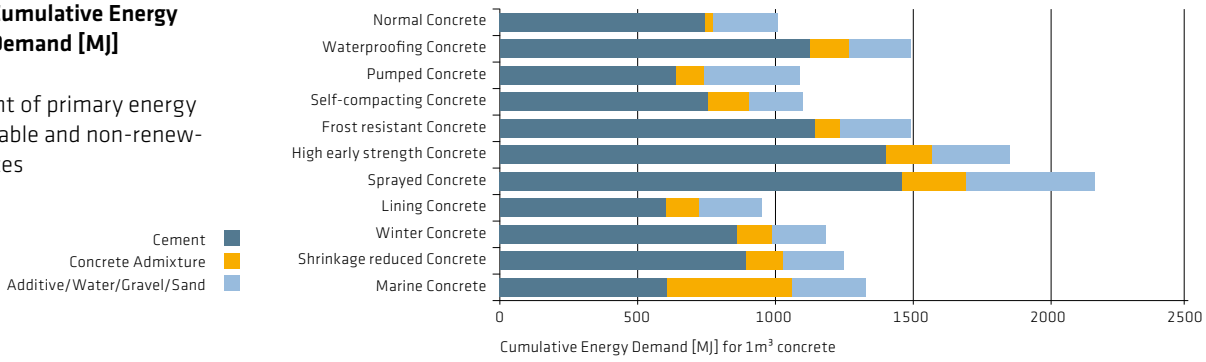
The data refers to 1 m^3 of exemplary concrete types

Concrete admixtures can improve the sustainability of concrete in many different ways. Firstly, admixtures can improve the quality and performance of concrete significantly, which in return extends its service life. In addition, thanks to the use of admixtures the application of concrete instead of other building materials can improve the life cycle of infrastructures, i.e. concrete roads greatly improve the quality and durability of highways for main traffic arteries compared with conventional road surfacing.
Further, the addition of special admixtures, such as stabilizing or water reducing admixtures also enables the use of alternative and recycled materials, such as recycled aggregates, for the production of good quality concrete. Finally, in many cases the energy required to produce certain cement or concrete mixes will be positively impacted with the use of admixtures. One example is the addition of water reducing and accelerating admixtures to obtain high early strengths in precast concrete to greatly reduced or even completely replaced external heating of elements.

COMPARISON OF DIFFERENT CONCRETE TYPES

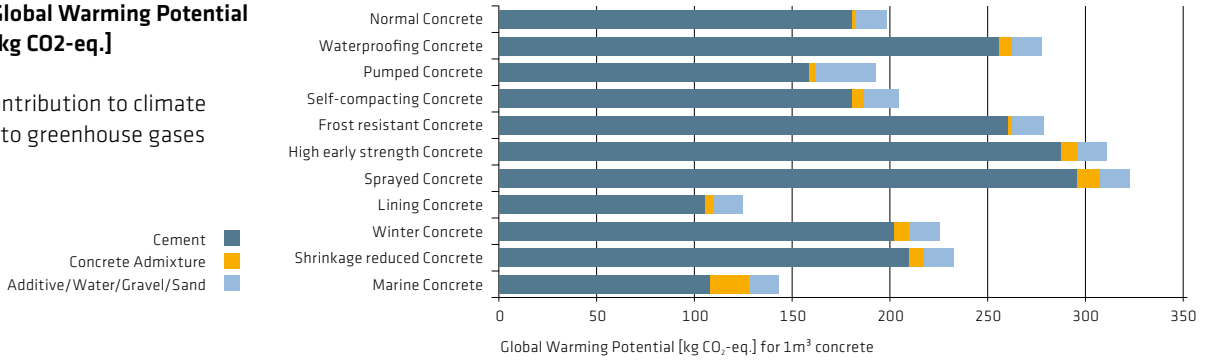
Cumulative Energy Demand [MJ]

Total amount of primary energy from renewable and non-renewable resources



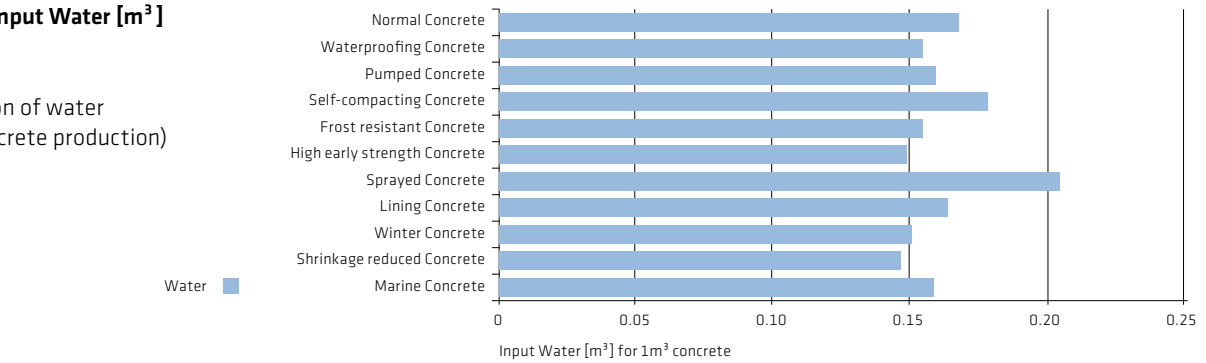
Global Warming Potential [kg CO2-eq.]

Potential contribution to climate change due to greenhouse gases emissions



Input Water [m^3]

Consumption of water (for the concrete production)



1 MILLION TON ETHYLENE BUFFER TANK WITH Sika® ViscoCrete®

PROJECT
INEOS built a 1 million tons ethylene concrete buffer tank in Belgium. The total concrete volume is about 3'400 m^3. Special concrete properties are required for the placement as slipped form concrete. To optimize that type of concrete recipe in respect to sustainability is a challenge.

SIKA SOLUTIONS
Accelerated and mix design optimized concrete for slipped form concrete.
The optimization of the mix design by reducing the cement content and the use of a special Superplasticizer allowed achieving the required concrete performances as:

- Good placing properties with low compaction energy
- Achieving early green strength properties for the continuously production process
- Generate a smooth surface for the contniuosly move of the formworks

LIFE CYCLE IMPACT ASSESSMENT
Life Cycle Impact Assessment of two concrete systems to compare the impact of the use of Sika® ViscoCrete®.

Concrete Systems	Components				
	Cement	Sand	Gravel	Water	Concrete Admixture
Paste Volume: 343 liter Traditional Superplasticizer	CEM III/A 42.5 N LA 442 kg/m^3	Sand round 0/4 678 kg/m^3	Gravel round 2/32 1,017 kg/m^3	203 liter	1% Sikament® 4.4 kg/m^3
Paste volume: 310 liter PCE Superplasticizer	CEM III/A 42.5 N LA 400 kg/m^3	Sand round 0/4 712 kg/m^3	Gravel round 2/32 1,068 kg/m^3	184 liter	1% Sika® ViscoCrete® 4.0 kg/m^3

DEFINITION LIFE CYCLE IMPACT ASSESSMENT

- 'Cradle to Gate', including packaging of the Concrete Admixtures (IBC container)
- Functional Unit: 1 m^3 concrete
- Modeled in the software GaBi, from Thinkstep according to the ISO 14040 series and EN 15804

SAVING POTENTIAL ETHYLENE BUFFER TANK
Concrete volume: 3,400 m^3
Energy savings equivalent to 9,000 liter oil
Carbon savings equivalent to 56,000 km (truck 15 ton)

PASTE VOLUME OPTIMIZED CONCRETE WITH Sika® ViscoCrete®

REQUIREMENTS
Based on existing concrete recipes for all type of Argos concrete types the target was to:

- To optimize costs of concrete recipes
- No negative influence of fresh concrete properties
- To improve quality of hardened concrete
- Increase concrete recipe sustainability

Special requirements
For every type of concrete placing the requirements vary regarding the fine fraction portion of the design mix. Along with this of course the larger components play a role, but this is of considerably lesser significance. The coarse grains form primarily the scaffolding and serve as filling material.
On the basis of innumerable concrete mix designs over many decades, ranges of fines content and mortar quantities can be indicated for various types of installation which lead to a correct result also with differing aggregate components, or respectively take these fluctuations into consideration.

SIKA SOLUTIONS
By using the Sika paste volume optimization approach it is possible to improve hardened concrete properties in line with reducing costs of the recipe and improving life cycle aspects of the concept. Under this consideration, customer ends up with significant reduction of cement content.

Fresh concrete properties
As soon as the paste volume with constant w/c-ratio is reduced in the meantime we reduce the fine content in the mix. This is possible as long the fresh concrete properties will not be influenced negatively.

Hardened concrete properties
the reduction of cement content with constant w/c-ratio will end in improved concrete durability behaviours as long as there the required workability behaviour will be achieved.

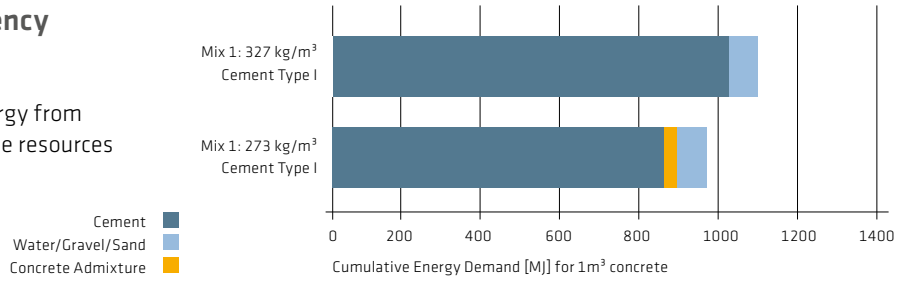
Placing method	Fines content	Fine mortar paste	Remarks
Crane & Bucket Concrete	–	250 to 280 L/m³	The fine mortar paste contains: cement, powder additives, fines from sand ≤ 0.125 mm + water
Pumped concrete	> 375 kg/m³ with max. grain 32 mm	280 to 320 L/m³	
Self-compacting concrete (SCC)	> 500 kg/m³ with max. grain 16 mm	320 to 380 L/m³	

LIFE CYCLE IMPACT ASSESSMENT

Environmental impacts and resource inputs

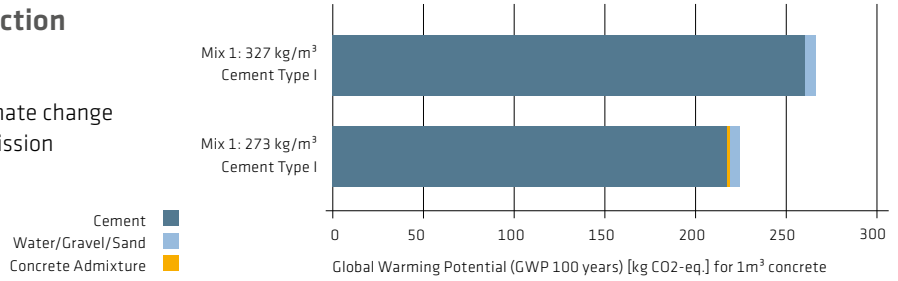
Energy Efficiency

Total amount of primary energy from renewable and non-renewable resources



Climate Protection

Potential contribution to climate change due to greenhouse gases emission



LIFE CYCLE IMPACT ASSESSMENT

Life Cycle Impact Assessment of two concrete systems to compare the impact of the use of Sika® ViscoCrete®

Concrete Systems		Components				
		Cement	Additive	Sand / Gravel	Water	Concrete Admixture
Cement paste Fina paste	**290 liter** **321 liter**	Cement Type I 327 kg/m³	–	798 kg/m³ 916 kg/m³	w/c-ratio = 0.57 187 liter	0.56% traditional Plasticizer
Cement paste Fine paste	**242 liter** **275 liter**	Cement Type I 273 kg/m³	–	845 kg/m³ 952 kg/m³	w/c-ratio = 0.57 155 liter	0.38% Plastiment® 0.45% Sika® ViscoCrete

DEFINITION LIFE CYCLE IMPACT ASSESSMENT

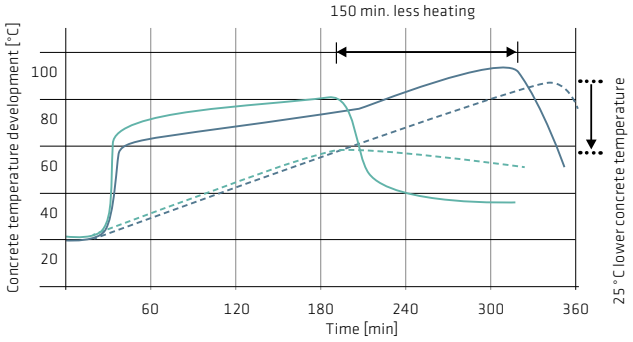
- 'Cradle to Gate', including packaging of the Concrete Admixtures (IBC container)
- Functional Unit: 1 m³ concrete
- Modeled in the software GaBi, from Thinkstep accorfing to the ISO 14040 series and EN 15804

PASTE VOLUME OPTIMIZED CONCRETE
Concrete Volume per 10,000 m³
Energy savings equivalent to 31,000 liter oil
Carbon savings equivalent to 450,000 km (truck 15 ton)

TUNNELSEGMENT PRODUCTION WITH SikaRapid®

REQUIREMENTS

Due to the large numbers required and heavyweight (up to several metric tons each), tunnel segments are almost always produced close to the tunnel portal in specially installed precasting facilities. They have to meet high accuracy specifications. Heavy steel formwork is therefore the norm. Because striking takes place after only 5 – 6 hours and the concrete must already have a compressive strength of >15 N/mm², accelerated strength development is essential. There are several methods for this. In the autoclave (heat backflow) process, the concrete is heated to 28 – 30 °C during mixing (with hot water or steam), placed in the form and finished. It is then heated for about 5 hours in an autoclave at 50 – 60 °C to obtain the necessary strength for formwork removal.



Heating development and development of concrete temperature

SIKA SOLUTIONS

Improved concrete hardening in tunnel segment production. Tunnel segment production combines the challenge of realization of a specified high early strength and fulfilment of highest requirements regarding durability. Strength development is usually secured by utilization of heat or steam curing which can be contradictory to durability if the concrete core temperature is too high. The concrete performance regarding early strength and durability can be enhanced with the SikaRapid® technology.

Exemplary heating cycles with and without application of SikaRapid® and the resulting concrete temperature with the corresponding early strength can be seen in the graphics below. With the application of SikaRapid® the hardening process of the concrete was optimized, with the result that approximately 150 minutes of heating could be eliminated. At the same time the early and final strength requirements were attained. Moreover the durability of the tunnel segments was improved as the concrete peak temperature was limited to less than 60°C.

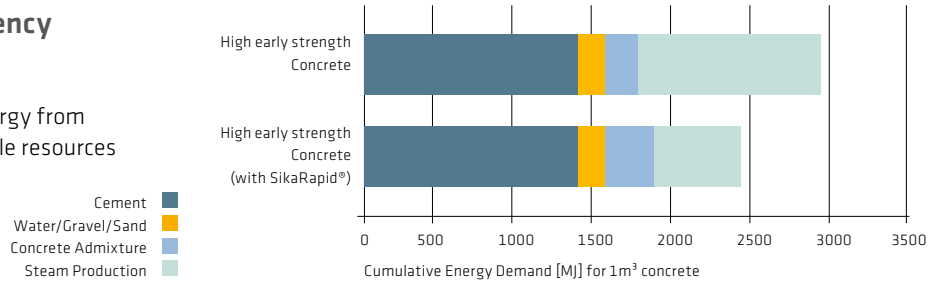
- Heating without SikaRapid®-1
- Concrete temperature without SikaRapid®-1
- Heating with SikaRapid®-1
- Concrete temperature with SikaRapid®-1

LIFE CYCLE IMPACT ASSESSMENT

Environmental impacts and resource inputs

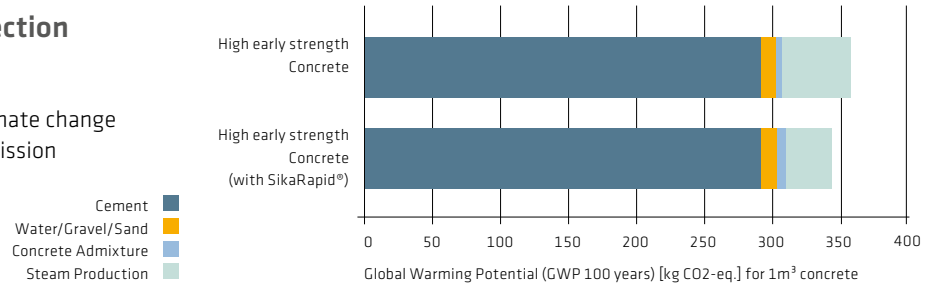
Energy Efficiency

Total amount of primary energy from renewable and non-renewable resources



Climate Protection

Potential contribution to climate change due to greenhouse gases emission



LIFE CYCLE IMPACT ASSESSMENT

Life Cycle Impact Assessment of two concrete systems to compare the impact in steam reduction with SikaRapid®-1

Concrete Systems	Components			
	Cement	Additive	Sand / Gravel	Concrete Admixture
Steam curing time: 300 min. High early strength concrete	CEM I 52,5 350 kg/m³	–	900 kg/m³ 1,030 kg/m³	Sika® ViscoCrete® 20 HE
Steam curing time: 150 min. High early strength concrete with SikaRapid®	CEM I 52,5 350 kg/m³	–	900 kg/m³ 1,030 kg/m³	Sika® ViscoCrete 20® HE SikaRapid®-1

DEFINITION LIFE CYCLE IMPACT ASSESSMENT

- 'Cradle to Gate', including packaging of the Concrete Admixtures (IBC container) and production of steam
- Functional Unit: 1 m³ concrete
- Modeled in the software GaBi, from Thinkstep accorfing to the ISO 14040 series and EN 15804

SAVING POTENTIAL TUNNEL SEGMENT PROJECT

Length: 5 km / Diameter: 14 m / Thickness elements: 30 cm
Energy savings equivalent to 687'000 liter oil
Carbon savings equivalent to 1.50 Mio km (truck 15 to)

SIKA ADMIXTURE CONTRIBUTION TO SUSTAINABLE CONSTRUCTION

CONCRETE ADMIXTURE ENVIRONMENTAL PRODUCT DECLARATION

An Environmental Product Declaration (EPD) is a standardized way of communicating the environmental impact for a product or product group based on quantitative data from Life Cycle Assessment (LCA). EPDs are verified and certified by an independent third party.

EPD for Sika concrete admixtures are developed by EFCA and available for the most important product groups

EFCA EPD's for:

- Plastiment® / Plastocrete®
- Sikament® / SikaPlast®
- Sika® ViscoCrete® / Sika® ViscoFlow®
- SikaRapid® / Sigunit® / Sika® Antifreeze
- SikaAer® / Sika® WT
- Sika® Retarder / SikaTard®

'GREEN BUILDING' CERTIFICATION PROGRAMS

Over recent years, several countries and organizations have developed environmental certification programs for buildings, like LEED, BREEAM or DGNB. Practical experiences together with their new findings have led to continuing adaptation and extensions of these programs. The criteria for the different programs are similar, whilst the evaluation can still differ substantially. Most Green Building Certification Programs focus on assessing whole buildings, rather than individual building systems or products.

Sika Concrete Admixtures can contribute to making concrete fulfill several requirements within these programs, such as:

- Concrete durability
- Pervious concrete for storm water design
- Recycled content in concrete (aggregates or supplementary cementitious materials)
- Reduction of concrete impacts, optimization of cement content and type

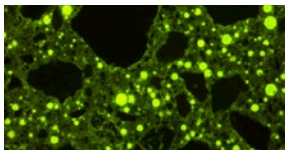
SIKA SUSTAINABLE SOLUTIONS

Concrete systems contribute to sustainable construction

Durability: More Value

Several admixtures will allow for the production of concrete with extended durability in regular circumstances or even in a severe environment.

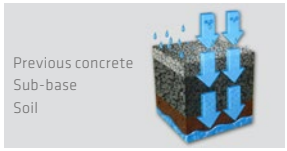
- Sika® ViscoCrete®
  minimizes porosity in the cement matrix significantly
- Sika® Control AER
  improves freeze/thaw resistance of concrete
- Sika® Control SRA
  reduces drying shrinkage of concrete



Application: More Value

The use of the right admixtures allows for the production of specialty concrete, which offer environmentally friendly applications or can be used instead of other building materials (i.e. pervious concrete, insulating concrete).

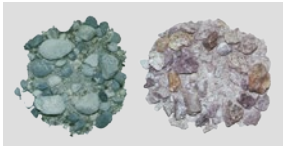
- Sika® ViscoFlow®
  Self Compacting Concrete (SCC) enables the reduction of a structure's dimensions (wall thickness)
- Sika® Stabilizer
  generates a stable paste layer around the aggregates
- SikaPlast®
  ensures a high quality paste



Source: Less Impact

Using alternative of recycled materials in a concrete mix often has a negative impact on the concrete fresh or hardened properties. Admixtures can be used efficiently to counter such effects.

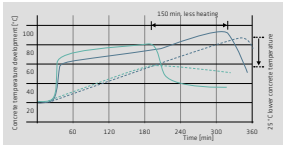
- SikaPlast® or Sika® ViscoCrete®
  ensure the use of concrete produced with recycled aggregates
- Sika® Stabilizer Pump
  allows efficient concrete placing with the use of manufactured and recycled aggregates
- SikaRapid®
  compensates for the loss of early strength by using SCM



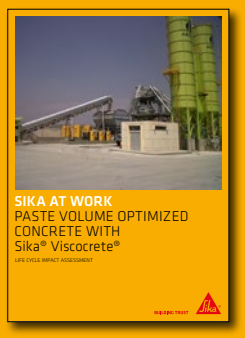
Energy: Less Impact

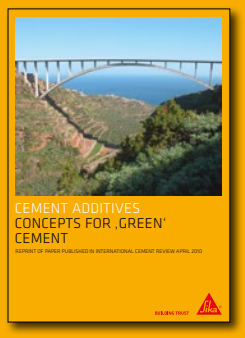
A lot of energy is used in the production, placement or curing of cement and concrete. Several admixture and additive solutions allow for a reduction of this process energy.

- Sika® ViscoCrete® or SikaPlast®
  offset the negative influence on final strength of the cement reduction through water reduction
- SikaGrind®
  reduces of time to grind cement of a specified fineness
- SikaRapid®
  allows for a reduction of steam curing in precast element production



ALSO AVAILABLE FROM SIKA





FOR MORE INFORMATION:

WE ARE SIKA
Sika is a specialty chemicals company with a leading position in the development and production of systems and products for bonding, sealing, damping, reinforcing and protecting in the building sector and the motor vehicle industry. Sika's product lines feature concrete admixtures, mortars, sealants and adhesives, structural strengthening systems, flooring as well as roofing and waterproofing systems.

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