XYPEX®

ADMIX C-1000/C-1000 NF

CEMENTITIOUS CRYSTALLINE

Concrete Waterproofing

Description

Xypex is a unique chemical treatment for the waterproofing, protection and improvement of concrete. XYPEX ADMIX C-1000/C-1000 NF is added to the concrete mix at the time of batching. Xypex Admix C-1000/C-1000 NF consists of Portland cement, silica sand (excluding the NF grade) and various active, proprietary chemicals. These active chemicals react with the moisture in fresh concrete and with the byproducts of cement hydration to cause a catalytic reaction. This reaction generates a non-soluble crystalline formation throughout the pores and capillary tracts of the concrete that permanently seals the concrete and prevents the penetration of water and other liquids from any direction.

Xypex Admix C-Series

All variations of the Admix C-Series contain the same amount of reactive chemicals at their prescribed dosage rates and provide the same waterproofing and durability performance characteristics. Xypex Admix C-Series is available in regular or no-fines grades (NF). **Xypex Admix C-500/C-500 NF** is formulated to have minimal or no effect on setting time. **Xypex Admix C-1000/C-1000 NF** is formulated for concrete mix designs where a normal or mildly delayed set is desired. **Xypex Admix C-2000** is designed for warmer climates and projects where a slower hydration rate is typically required. See Setting Time and Strength for more details. Consult with a Xypex Technical Services Representative for the most appropriate Xypex Admix for your project.

Recommended for:

- Reservoirs
- Sewage and Water Treatment Plants
- Secondary Containment Structures
- Tunnels and Subway Systems
- Underground Vaults
- Foundations / Basements
- Parking Structures
- Swimming Pools
- Precast Components
- Bridge Structures

Advantages

- Resists extreme hydrostatic pressure
- Becomes an integral part of the substrate
- Highly resistant to aggressive and chemical environments
- Can seal static hairline cracks up to 0.5 mm
- Allows concrete to breathe
- Non-toxic
- No VOCs
- Less costly to install than most other methods
- Permanent
- Added to the concrete at time of batching and therefore is not subject to climatic restraints
- Increases flexibility in construction scheduling

For assistance with project requirements, please contact Xypex Technical Services Department.

Packaging

Xypex Admix C-1000/C-1000 NF is packaged in convenient sizes of various types of packaging, including pails, repulpable paper bags and soluble bags. Contact your local Xypex Technical Services Representative or dealer for details and availability.

Storage

Xypex products must be stored dry at a minimum temperature of 7ºC. Shelf life is one year when stored under proper conditions.

Dosage Rates

Xypex Admix C-1000 (Regular Grade):
2 - 3% by weight of cement

Xypex Admix C-1000 NF (No Fines Grade):
1 - 1.5% by weight of cement

NOTE:
i. For determining the appropriate dosage rate and for further information regarding concrete mixes containing fly ash / slag, enhanced chemical resistance, optimum concrete performance, or meeting the specific requirements and conditions of your project, consult with the local Xypex Technical Services Representative or Xypex's Technical Services Department.

ii. The recommended minimum dosage rate for Admix C-1000 (Regular Grade) is 6 kg per m^3; the maximum dosage is 12 kg per m^3. For Admix C-1000 NF (No Fines Grade), the minimum dosage is 3 kg per m^3; the maximum dosage is 6 kg per m^3.

iii. Under certain conditions the dosage rate for the Admix NF (No Fines Grade) may be as low as 0.8% depending on the quantity and type of total cementitious materials.

Material Properties

Visual Appearance	Light grey powder
pH	12.0 - 12.4
Chloride Content	<0.1%
VOC	none

Test Data

PERMEABILITY

U.S. Army Corps of Engineers CRD C48, "Permeability of Concrete", Aviles Engineering Corp., Houston, USA

Two concrete samples containing Xypex Admix and an untreated control sample were tested for water permeability. Both the treated and untreated samples were subjected to a pressure of 150 psi / 1.04 MPa (350 ft. / 106.7 m water head). Results showed moisture and permeated water throughout the untreated sample after 24 hours. However, the Xypex Admix samples showed no leakage, and water penetration of only 1.5 mm / 0.06 inches after 120 hours (5 days).

U.S. Army Corps of Engineers CRD C48, "Permeability of Concrete", Setsco Services, Pte Ltd., Singapore

Six Xypex Admix-treated and six untreated concrete samples were tested for water permeability. Pressure was gradually increased over five days and then maintained at 7 bars (224 ft. / 68.3 m water head) for 10 days. While the six reference samples showed water leakage beginning on the fifth day and increasing throughout the test period, the Xypex Admix samples showed no water leakage at any time during the test.

ACCI Water Permeability Test, "Water Permeability of Concrete", Australia Centre of Construction and Innovation, University of New South Wales, Sydney, Australia

Concrete samples containing Xypex Admix NF at a dosage rate of 0.8% and 1.2% were tested for water permeability against control samples. All the samples were subjected to a pressure of 10 bars (100 meters / 328 ft. water head) for 2 weeks. Water permeability coefficients were calculated and the Xypex Admix treated concrete showed significant reduction in water permeability by up to 93% at a dosage rate of 1.2%.

STN EN 12390-8, "Testing of Hardened Concrete; Depth of Water Penetration Under Pressure", Technical and Testing Construction Institute, Bratislava, Slovakia

Concrete cubes were prepared with Admix C-1000 at 2% and Admix C-1000 NF at 1% along with control cubes. A water pressure of 0.5 MPa was applied for 72 hrs and specimens were subsequently split transversely to measure depth of water penetration. Depth results for C-1000/C-1000 NF were 10.3 mm and 25 mm respectively, whereas penetration on control samples was 113 mm. In using the Valenta equation to calculate the water permeability coefficient, the C-1000/C-1000 NF treated concrete showed a 20 to 120x reduction compared to the control concrete.

COMPRESSIVE STRENGTH

ASTM C 39, "Compressive Strength of Cylindrical Concrete Specimens", Kleinfelder Laboratories, San Francisco, USA

At 28 days, the compressive strength test of the concrete containing Xypex Admix measured 7160 psi / 49.5 MPa as compared to the reference sample at 6460 psi / 44.5 MPa (a 10% increase).

CHEMICAL RESISTANCE

CSN 73 1326, "Measuring Loss of Surface Due to Sulphate Attack of Concrete Treated with Admix C-1000/Admix C-1000 NF", Betonconsult, Building Materials Testing Laboratory, Prague, Czech Republic

Concrete specimens treated with Admix C-1000 at 1% and 2%, and Admix C-1000 NF at 0.5% and 1% were cast along with non-treated concrete specimens. The specimens were exposed to a highly concentrated sulphate solution (i.e. 36,000 mg/ℓ) for 4 months and samples were periodically weighed to determine mass loss. The Admix treated samples recorded a mass loss between 5 and 50 g/m^2 and showed no surface deterioration, while the non-treated specimens measured an average mass loss of 4,860 g/m^2 with significant surface deterioration.

HB 84-2006, "Durability Assessment of Reinforced Concrete Structure Containing Xypex Admix Exposed to 19 Years of Severe Marine Environment", Sharp and Howells Pty. Ltd. Chemical Laboratories, Victoria, Australia

Lascelles Wharf serves as a bulk chemical and grain dock. In 1995, as part of an extensive maintenance program and to protect new precast concrete panels from the extremely harsh and aggressive marine environment, the concrete was dosed with Xypex Admix C-Series at 1%. Recently tests were conducted to predict "initiation time to corrosion". Extracted cores were tested for chloride content at incremental depths into the concrete. Chloride content profiles, concrete cover, surface chloride content, and chloride corrosion threshold were used in a model based on Fick's 2nd law to predict the residual service life of this structure. The average initiation time to corrosion was estimated at 164 years; whereas, the structure had been designed for 50 years of service life.

NT BUILD 443, "Chloride Diffusion by NordTest with 16.5% NaCl Solution of 40 MPa Concrete Containing Admix C-1000 NF", Australia Centre for Construction Innovation, University of New South Wales, Sydney, Australia

The NordTest NT BUILD 443 is a standard accelerated method for evaluation of the chloride diffusion coefficient of concrete. In this test program, concrete mixes with 25% fly ash, 38% slag, and 60% slag were cast (total cementitious content = 435 kg, 0.4 w/c). Xypex Admix C-1000 NF at 0.8% and 1.2% by weight of cementitious materials were compared to control mixes (for each cement system). All specimens were immersed in a 16.5% NaCl solution for 35 days. Chloride diffusion coefficient was calculated based on the chloride profile, utilizing Fick's 2nd law. Admix treated fly ash concrete showed 25% reduced chloride diffusion coefficient for both 0.8% and 1.2% addition. The Admix treated

38% slag concrete recorded a 67% lower chloride diffusion coefficient at 0.8% addition and 75% lower at 1.2% addition. The reduction of chloride diffusion coefficient was 42% and 53% for high slag mixes for 0.8% and 1.2% addition respectively.

"Sulfuric Acid Resistance Test", Aviles Engineering Corporation, Houston, USA

Concrete containing Xypex Admix at different dosage rates including 3% specimens were tested against untreated control samples for sulfuric acid resistance. After immersion in the sulfuric acid, each sample was tested for weight loss on a daily basis until a weight loss of 50% or a definite response trend was obtained. The percentage weight loss of the samples containing Xypex Admix tested significantly lower than the control samples.

"Acid Resistance of Mortar Containing Xypex Admix C-1000 NF", Construction and Maintenance Technology Research Center (CONTEC), Sirindhorn International Institute of Technology (SIIT) - Thammasat University, Bangkok, Thailand

An acid testing regime was part of an extensive program to determine the benefit of the Xypex Admix C-1000 NF dosed at 1% to improve the durability of concrete. Several comparative mixes were utilized in this evaluation, including: a plain Portland cement and a 30% fly ash mix. Cured samples were exposed to 5% H_2SO_4; the pH value of this acid solution was 0.25 and never greater than 0.54 pH. In this extremely acidic, corrosive environment, at 12 weeks the Admix samples reduced the weight loss by 48% compared to controls of the cement-only mortar, and 53% in the fly ash specimens.

CRACK SEALING

ASTM C1585 and ASTM C1202, "Evaluation of Self-healing Capability of Self-compacting Concrete Made with Blast-furnace Slag Cements Activated by the Xypex Crystalline Catalyst", Instituto Tecnologico de Aeronautica, Sao Jose dos Campos, Brazil

Portland, blast furnace slag and slag-modified Portland concrete samples, treated with 2.5% Admix C-500, were evaluated for self-healing capabilities. Microcracks were induced by loading to 90% of ultimate compressive strength. Cracked samples were then immersed in water to trigger self-healing after 28, 56 and 84 days. Strength and ultrasonic pulse velocity tests were used to determine mechanical recovery; sorptivity and rapid chloride permeability were used to evaluate watertightness recovery. Results substantiated the ability of Xypex Admix to provide self-healing of cracked concrete.

"Testing of Xypex Admix C-1000 NF Crack Healing Capabilities", CH Karnchang (Lao) Company Ltd., Xayaburi Laboratory, Ban Xieng Yeun, Vientiane, Laos

Prior to construction of a Mekong River dam, testing was undertaken to substantiate the ability of Xypex Admix to self-heal static cracks. Three large concrete slabs treated with Admix C-1000 NF at 0.8% were cast along with three control slabs. Following curing, a force was applied at the mid-point of each slab to create cracks with widths from 0.2 to 0.5 mm on the surface. Water was ponded above the cracked area. Initially all cracks leaked; at 4 days all dripping had ceased from the cracks of the Xypex treated panels, while leaking continued through the cracks of the control slab until the end of the test period (25 days). SEM photographs showed significant crystalline growth throughout the cracks of the Admix treated slab.

SCANNING ELECTRON MICROSCOPY

SEM "Microscopic Examination of Crystalline Products in Three Xypex Admix Modified Concrete Mortars", Australian Centre for Construction Innovation, University of New South Wales, Sydney, Australia

Slag and fly ash blended cement samples were treated with Xypex Admix and examined for evidence of crystalline growth at ages ranging from 8 months to 2 years. Samples were sliced and/or split and examined at magnifications between 500x and 5000x. Characteristic Xypex crystalline growth was observable on all Xypex treated samples, providing evidence of Xypex crystalline reactions with fly ash and slag blended cements.

FREEZE/THAW DURABILITY

ASTM C 666, "Freeze/Thaw Durability", Independent Laboratory, Cleveland, USA

After 300 freeze/thaw cycles, the Xypex Admix-treated samples indicated 94% relative durability.

POTABLE WATER EXPOSURE

NSF 61, "Drinking Water System Component-Health Effects", NSF International, Ann Arbor, USA

Exposure testing of potable water in contact with Xypex-treated samples indicated no harmful effects.

Directions for Use

Xypex Admix C-1000/C-1000 NF is added to the concrete at the time of batching. It is important to obtain a homogeneous mixture of Xypex Admix with the concrete. Do not add dry Admix powder directly to wet mixed concrete as this could cause clumping and thorough dispersion may not occur. The sequence of procedures for addition will vary according to the type of batch plant operation and equipment. The following methods have been used successfully in the past and it is recommended that the local Xypex Technical Services Representative be consulted about the best method to use.

1. ADDITION TO COARSE AGGREGATE BELT Add Xypex Admix in bulk powder form, soluble bags or repulpable bags directly to the coarse aggregate conveyor belt manually or through computer controlled mass batching system. Account for worker health and safety issues with moving belts and wind-blown dust issues.

2. TRUCK ADDITION (AT PLANT) Add Xypex Admix in bulk powder form, soluble bags or repulpable bags to the drum of the ready-mix truck immediately prior to driving the truck under the batch plant and adding the balance of the materials or the premixed concrete in accordance with standard concrete batching practices. Measures to ensure soluble bags or repulpable bags are dispersed include adding the bags as far forward in the drum as possible, adding a small amount of batch water with the bags, and spinning the drum prior to adding remaining ingredients. Avoid delays in adding other components and utilize high speed mixing to ensure homogeneity of mix. Additional high speed mixing time may be required when using repulpable bags. Where there may be insufficient water for thorough dispersion of the bulk powder, a water slurry can be made with the Admix and added to the truck mixer drum prior to batching. Account for added water in the mix design and slump.

3. ADDITION TO CENTRAL MIXER Add Xypex Admix in bulk powder form, soluble bags or repulpable bags along with the other components. Mix as per standard batching practices to ensure thorough dispersal of the Admix resulting in a homogeneous mixture. Additional high speed mixing time may be required when using repulpable bags. Account for worker safety issues when accessing the equipment.

NOTE:

i. Although addition on site in powder form is not normally recommended, it may be necessary. In such a case, add Xypex Admix to truck in slurry form (e.g. 3 parts powder to 2 parts water by volume). Mix concrete for a minimum of 5 minutes on high speed or until thoroughly dispersed. Account for added water in the mix design and slump.

ii. Concrete containing the Xypex Admix does not preclude the requirement for design of crack control, construction joint detailing, proper placement, consolidation and curing of the concrete and measures for repairing defects such as honeycombing, tie holes, cracks beyond specified limits.

iii. Further guidelines are available that address the use of Xypex Admix for a specific situation, (e.g. dry mixes, use of ice in hot ambient conditions, cold-weather concreting, etc.). Consult with a local Xypex Technical Services Representative or Xypex's Technical Services Department for further information.

Setting Time and Strength

The setting time of concrete is affected by the chemical and physical composition of ingredients, temperature of the concrete and climatic conditions. Xypex Admix C-1000/C-1000 NF is designed for concrete mix designs where a normal or mildly delayed set is desired. Concrete containing the Admix C-1000/C-1000 NF may develop higher ultimate strengths than plain concrete. Trial mixes should be carried out under project conditions to determine the setting time and strength of the concrete dosed with Admix C-1000/C-1000 NF. Consult with a Xypex Technical Services Representative for the most appropriate Xypex Admix for your project.

Limitations

When incorporating Xypex Admix, the temperature of the concrete mix should be above 4ºC.

Technical Services

For more instructions, alternative installation methods, or information concerning the compatibility of the Xypex treatment with other products or technologies, contact the Technical Services Department of Xypex Chemical Corporation or your local Xypex Technical Services Representative.

Certification

Xypex Admix satisfies the requirements of EN-934-2; Initial Type Testing (ITT) according to EN-934-2 was certified by BSI as the Notifying Body.

Safe Handling Information

Xypex is alkaline. As a cementitious powder or mixture, Xypex may cause significant skin and eye irritation. Directions for treating these problems are clearly detailed on all Xypex pails and packaging. The Manufacturer also maintains comprehensive and up-to-date Safety Data Sheets on all its products. Each sheet contains health and safety information for the protection of workers and customers. The Manufacturer recommends you contact Xypex Chemical Corporation or your local Xypex Technical Services Representative to obtain copies of Safety Data Sheets prior to product storage or use.

Warranty

The Manufacturer warrants that the products manufactured by it shall be free from material defects and will be consistent with its normal high quality. Should any of the products be proven defective, the liability to the Manufacturer shall be limited to replacement of the product ex factory. The Manufacturer makes no warranty as to merchantability or fitness for a particular purpose and this warranty is in lieu of all other warranties expressed or implied. The user shall determine the suitability of the product for his intended use and assume all risks and liability in connection therewith.

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EPD™

Environmental Product Declaration

Global GreenTag EPD Program:

Compliant to EN15804+A2 2019

Xypex Chemical Corporation

Xypex Admix C-1000 NF

13731 Mayfield Place, Richmond
British Columbia, Canada

XYPEX® Concrete Waterproofing by Crystallization™

Xypex Admix C-1000 NF
EPD XYP09 2023EP

Mandatory Disclosures

EPD type	Cradle to grave A1 to C4 + D	**EPD Numbers**	XYP09 2023EP
Issue Date	28 August 2023	**Valid Until**	28 August 2028

Demonstration of Verification		
PCR	Standard EN 15804+A2 2019 serves as core Product Category Rules (PCR) [1]. Sub-PCR UCM:2023 Unreinforced Concrete Mixtures and Additives also applies [2].	
☑ Internal	Delwyn Jones 22 Aug 2023	LCA Developed by Delwyn Jones, The Evah Institute
	22.08.2023	LCA Reviewed by Direshni Naiker The Evah Institute
		EPD Reviewed by David Baggs, Global GreenTag Pty Ltd
☑ External	22/08/2023	Third Party Verifier[a] Mathilde Vlieg Malaika LCT
	a. Independent external verification of the declaration and data, mandatory for business-to-consumer communication according to ISO 14025:2010 [2].	
Communication	This EPD discloses potential environmental outcomes compliant with EN 15804 for business-to-business communication.	
Comparability	Construction product EPDs may not be comparable if not EN15804 compliant. Different program EPDs may not be comparable. Comparability is further dependent on the product category rules and data source used.	
Reliability	LCIA results are relative expressions that do not predict impacts on category endpoints, exceeding of thresholds, safety margins or risks.	
Owner	This EPD is the property of the declared manufacturer.	
Explanations	Further explanatory information is available at info@globalgreentag.com or by contacting certification1@globalgreentag.com [3].	

EPD Program Operator	**LCA and EPD Producer**	**Declaration Owner**
Global GreenTag Pty Ltd	Ecquate Pty Ltd	Xypex Chemical Corporation
PO Box 311 Cannon Hill	PO Box 123 Thirroul	13731 Mayfield Place, Richmond
QLD 4170 Australia	NSW 2515 Australia	British Columbia, Canada
Phone: +61 (0)7 33 999 686	Phone: +61 (0)7 5545 0998	Phone: +1 604.273.5265
http://www.globalgreentag.com	http://www.ecquate.com	https://www.xypex.com/

Concrete Waterproofing by Crystallization™

Program Description

EPD type	Cradle to grave A1 to C4 + D as defined by EN 15804 [1]
System boundary	The system boundary with nature includes material and energy acquisition, processing, manufacture, transport, installation, use plus waste arising to end of life.
Stages included	Stages A1-3 A4-5, B1-4, C1 to C2 and C4 D1 to D3
Stages excluded	No stage was excluded but flows and results for B5-B7 and C3 were all zero.
Scope Depiction	Figure 1 depicts all modules being declared including some with zero results. Any module not declared (MND) does not indicate a zero result.

Model	Actual			Scenarios													Potential		
Information	Building Life Cycle Assessment																Supplementary		
Stages	Product			Construct		Use							End-of-Life				Benefit & load beyond system		
Data Modules						Fabric					Operation								
Unit Operations	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D1	D2	D3
Cradle to Gate+ Options & Grave	Resources	Transport	Manufacture	Transport	Construct	Use	Maintain	Repair	Replace	Refurbish	Energy use	Water use	Demolish	Transport	Process Waste	Disposal	Reuse	Recovery	Recycling

Figure 1 EPD Life Cycle Modules Cradle to Grave

Data Sources

Primary Data	Data was collected from primary sources 2019 to 2022 including the manufacturer and suppliers' standards, locations, logistics, technology, market share, management system in accordance with EN ISO 14044:2006, 4.3.2, [4]. All are biochemical-physical allocated none are economically allocated.
A1-A3 Stage inclusions	Operations include all known raw material acquisition, refining and processing plus scrap or material reuse from prior systems; electricity generated from all sources with extraction, refining & transport plus secondary fuel energy and recovery processes. Also, transport to factory gate; manufacture of inputs, ancillary material, product, packaging, maintenance, replacement plus flows leaving at end-of-waste boundary and fate of all flows at end of life.
Variability	Significant differences of average LCIA results are declared.
Chemicals of Concern	Contains no substances in the European Chemicals Agency "Authorised or Candidate Lists of Substances of Very High Concern (SVHCs)".

Data Quality

Data cut-off & quality criteria complies with EN 15804 [1] The LCA used background data aged <10 years and quality parameters tabled below.

Background	**Data Quality**	**Parameters and Uncertainty (U)**			
Correlation	**Metric σg**	U ±0.01	U ±0.05	U ±0.10	U ±0.20
Reliability	**Reporting**	Site Audit	Expert verify	Region	Sector
	Sample	>66% trend	>25% trend	>10% batch	>5% batch
Completion	**Including**	>50%	>25%	>10%	>5%
	Cut-off	0.01%w/w	0.05%w/w	0.1%w/w	0.5%w/w
Temporal	**Data Age**	<3 years	≤5 years	<7.5 years	<10 years
	Duration	>3 years	<3 years	<2 years	1 year
Technology	**Typology**	Actual	Comparable	In Class	Convention
Geography	**Focus**	Process	Line	Plant	Corporate
	Range	Continent	Nation	Plant	Line
	Jurisdiction	Representation is Global. Africa, North America, Europe, Pacific Rim			

Product Information

At batching time the XYPEX admixture containing cement, lime, waterproofing and setting agents is added to the concrete mix. In contact with moisture in fresh concrete and cement hydration products these agents react to catalytically generate insoluble crystals. These crystals permanently seal concrete pores and capillary tracts throughout preventing liquid ingress from all directions.

Brand Name & Code	Xpyex Admix C-1000 NF	Range Names	Xypex Admixture
Factory warranty	One year	Reference Service Life	60 years [5,6]
Manufacturer	Xypex Chemical Corporation		
Manufacturer address	13731 Mayfield Place, Richmond British Columbia, Canada		
Site representation	Canadian and American		
Function in Building	Xypex products waterproof, protect and improve concrete.		
Functional unit	Cradle to grave concrete repair, remedial & waterproofing/kg 60years		

Product Components

This section summarises factory components, functions, source nation and % mass share. In product content listed below the % mass has a range and confidence interval that is 90% certain to contain true population means at any time. Listing such certainty considers normal resource acquisition, supply chain, sedimentation, seasonal, manufacturing and product variation over this EPD's validity period. This also allows for intellectual property protection whilst ensuring fullest possible transparency.

Function	Component	Cradle	Amount
Cement binder	Portland Cement	Canada	>40 <50
Crystalline waterproofing	Proprietary Base mix	Canada	>30 <40
Hydration	Hydrated Lime	Canada	>15 <25
Set retarder	Proprietary mineral	Canada	>4.0 <10
Packaging			
Pallet wood	Wood	Canada	>1.5 <2.0
Pail, Straps, Wrap & Tape	Polymers	Canada	>0.4 <0.5
Packaging	Cardboard and paper	Canada	>0.2 <0.3

Product Functional & Technical Performance Information

This section provides specifications and data to calculate results factoring different mass and period. For normal conditions, the dosage rate is 1 to 1.5% by weight of cement in the mix. The recommended minimum dosage for regular grade Admix C-1000 NF is 3kg/m^3 and the maximum is 6kg/m^3.

The sequence for addition will vary according to type of batch plant operation and equipment. As it is important to obtain a homogeneous blend of admixture within the concrete avoid adding dry admixture powder directly to wet mixed concrete as this could cause clumping that prevents thorough dispersion.

Safety Procedures	https://www.xypex.com/technical/safety-data
Specifications	https://www.xypex.com/technical/specifications
Practices Reference	https://www.xypex.com/learning-centre/faq
Installation Procedure	https://www.xypex.com/products/installations

System Analysis Scope and Boundaries

Stages A1 to 3 model actual operations. Stage A4 to C4 are model scenarios.

Typical scenarios are assumed to forecast unit operations as described in the next section.

Figure 2. shows included processes in a cradle to grave system boundary to end of life fates to unshown beyond the boundary reuse, recycling or landfill grave.

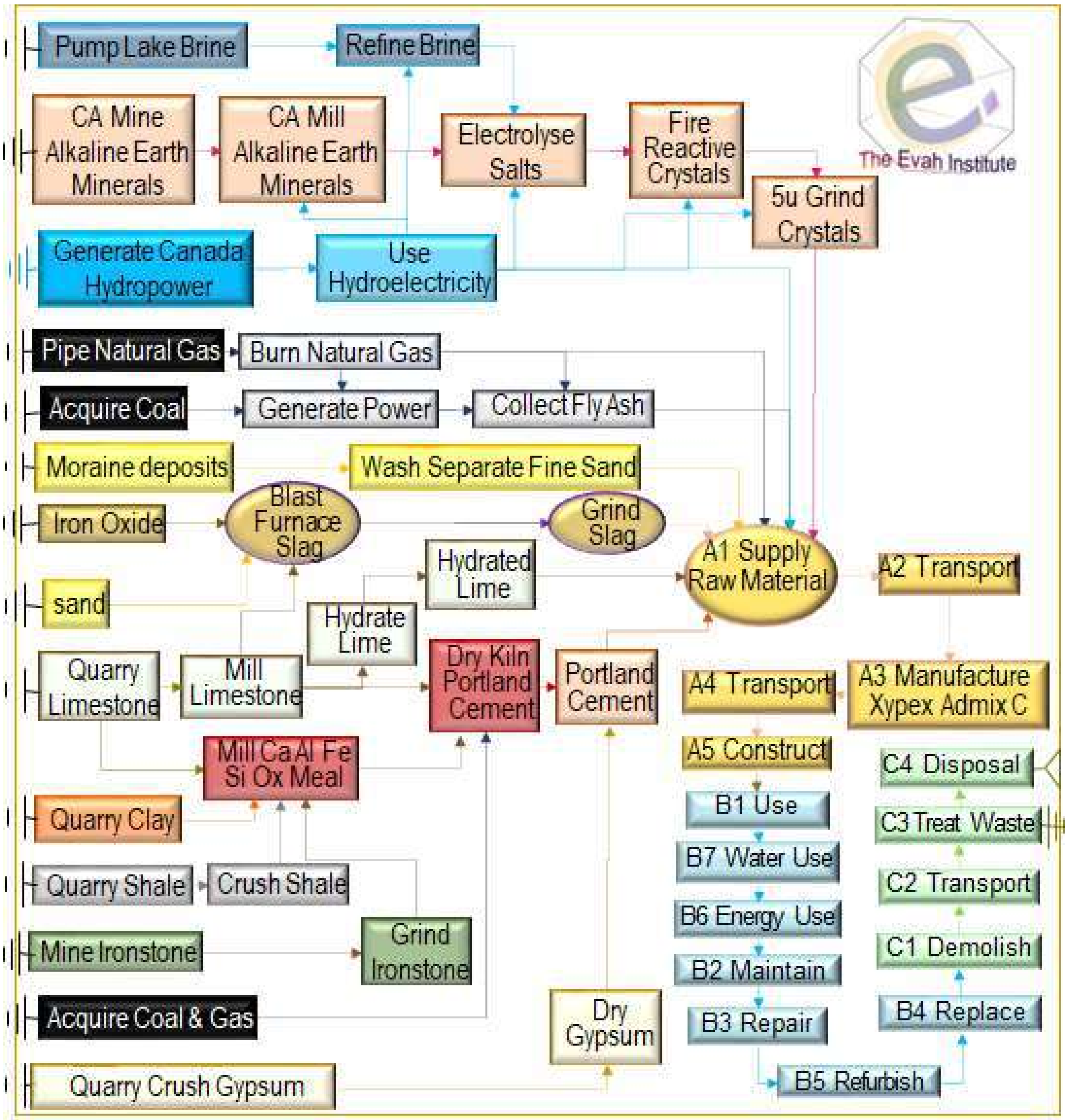

Figure 2. Product Process Flow Chart Completeness

Scenarios for Modules (Units/Functional Unit)

This section defines modelling scenarios beyond actual A1 to A3 operations from stage A4 to D3.

A Construction	Type specified	Amount	Type specified	Amount
A4 Transport to Site	25t semi-trailer	60km	85% Capacity	Full back load
Volume capacity (<1 to ≥1)	Utilisation factor	1	Uncompressed	Un-nested
A5 Installation utilities	Town water	0.53litre	Grid power	0.0002MJ
Waste on site	Spill	0.05kg		
Scrap collection & routes	25t semi-trailer	60km	to landfill	In LCA report

Stage B2 and B3 scenarios are listed below. Stages B1 Use of building fabric, B4 Replacement, B5 Refurbishment, B6 Building Operating Energy and B7 Building Operating Water all have zero flows.

B Building	Type specified	Amount	Type specified	Amount
B2 Maintenance	None typical	nil	Clean cycle	nil
B3 Repair 5%	As per website	Specified	Freight to site	As A5

Stage C1, C2 and C4 scenarios are listed below. Stage C3 Waste Treatment has zero flows.

C End of Life	Type specified	Amount	Type specified	Amount
C1 Demolition	Remove worn area	0.05kg	Collect separately	0.05kg
C2 Transport	25t truck road	50km	85% capacity	No back load
C4 Disposal	Product specific	0.05kg	Collect separately	0.05kg
Recovery system	No recycling	0.0kg	Not for energy	0.0kg

Stage D scenarios D1 Reuse and D2 Recovery are listed below. D3 Recycling has zero flows. Because of typical product durability no recycling was modelled. As buildings and infrastructure are demoshished, however, the product is fully recyclable.

D Beyond System Boundary	Type specified	Amount	Type specified	Amount
D1 Reuse	typically	95%	Patch 5%	0.05kg
D2 Recovery	typically	100%	Cleaning	sweep
D3 Recycle	At 60 years	Nil	None	0%

Environmental Impact Terminology

Environmental impacts contributing to risks of social and ecological issues and collapse are tabled below with common names and remedies given for each indicator.

Global warming forcing Climate Change	Greenhouse gases absorb infra-red radiation. This heat reduces thermal energy differentials, from equator to poles, forcing ocean current and wind circulation to blend and regulate climate. Weakly blended "lumpier" weather has more frequent, extreme heat wave, fire-storm, cyclone, rain-storm, flood and blizzard events. Accumulation of carbon dioxide, natural gas methane, nitrous oxides and volatile organic compounds from burning fossil fuels causes global warming. Forest and wilderness growth absorbing air-borne carbon in biomass can drawdown such accumulation. Urgent renewable energy reliance is vital in time to avoid imminent tipping points and the worsening "***climate emergency***".
Ozone layer depletion	Stratospheric ozone loss weakens the planet's solar shield so more shorter wavelength ultraviolet (UVB) light reaching earth damages plants and increases malignant melanoma and skin cancer in humans and animals. Chlorofluorocarbons, hydrochlorofluorocarbons (HCFC), chlorobromomethane, hydrobromofluorocarbons, carbon tetrachloride, methyl chloroform, methyl bromide and halon gas cause ozone layer loss. To repair the "***ozone hole***" reliance on ozone-safe refrigerants, aerosols and solvents is essential to avoid further its depletion and enable accumulation of naturally-formed ozone.
Acidification	Acidification reduces soil and waterway pH, impedes nitrogen fixation vital for plant growth and inhibits natural decomposition. It increases rates and incidence of fish kills, forest loss and deterioration of buildings and materials. Chief synthetic causes of "***acid rain***" are emissions of sulphur and nitrogen oxides, hydrochloric and hydrofluoric acids and ammonia from burning fossil fuels polluting precipitation of rain and snow world-wide.
Eutrophication of terrestrial, freshwater and marine life	Eutrophication from excessively high macronutrient levels added to natural waters promotes excessive plant growth that severely reduces oxygen, water and habitat security for aquatic and terrestrial organisms across related ecosystems. Chief synthetic cause of "***algal blooms***" is nitrogen (N, NOx, NH_4) and phosphorus (P, PO_4^{3-}) in rain run-off over-fertilised land catchments.
Photochemical ozone creation	Tropospheric photochemical ozone, called "***summer smog***" near ground level, is created from natural and synthetic compounds in UV sunlight. Low concentration smog damages vegetation and crops. High concentration smog is hazardous to human health. Chief synthetic causes are nitrogen oxides, carbon monoxide and volatile organic compounds (VOC) pollutants. Avoiding reliance on dirtiest coal fuel and volatile chemicals has reduced smog incidence in many areas globally.
Depletion of minerals, metals & water	Abiotic depletion of finite mineral resources increases time, effort and money required to obtain more resources to the point of extinction of naturally viable reserves. This can limit access to available, valuable and scarce elements vital for human-life. The youth movement "***extinction rebellion***" calls on adults to secure climate, reserves and biodiversity for current and future generations.
Depletion of fossil fuel reserves	Abiotic depletion of resources by consuming finite oil, natural gas, coal and yellowcake fossil fuel reserves leaves current and future generations suffering limited available, accessible, plentiful, essential valuable as well as scarce raw material, medicinal, chemical, feedstock and fuel stock. Approaching "***peak oil***" acknowledged fossil fuel reserves are finite and the need for decision-makers to act to avoid market instability, insecurity and or oil and gas wars.

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Glossary of Terms, Methods and Units

Acronyms, methods and units of impact potentials plus inventory inputs and outputs, are defined below

Impact Potentials	Acronym	Description of Methods	Units
Climate Change biogenic	GWP_{bio}	GWP biogenic [7]	kg CO_{2eq}
Climate Change luluc	GWP_{luluc}	GWP land use & change [7]	kg CO_{2eq}
Climate Change fossil	GWP_{ff}	GWP fossil fuels [7]	kg CO_{2eq}
Climate Change total	GWP_{t}	Global Warming Potential [7]	kg CO_{2eq}
Stratospheric Ozone Depletion	ODP	Stratospheric Ozone Loss [8]	kg CFC_{11eq}
Photochemical Ozone Creation	POCP	Summer Smog [9]	kg NMOC eq
Acidification Potential	AP	Accumulated Exceedance [10]	mol H^{+}_{eq}
Eutrophication Freshwater	EP_{fresh}	Excess nutrients freshwater [11]	kg P_{eq}
Eutrophication Marine	EP_{marine}	Excess marine nutrients [11]	kg N_{eq}
Eutrophication Terrestrial	EP_{land}	Excess Terrestrial nutrients [11]	mol N_{eq}
Mineral & Metal Depletion	ADP_{min}	Abiotic Depletion minerals [12]	kg Sb_{eq}
Fossil Fuel Depletion	ADP_{ff}	Abiotic Depletion fossil fuel [13]	MJ_{ncv}
Water Depletion	WDP	Water Deprivation Scarcity [14, 15]	$m^3_{WDP\ eq}$
Fresh Water Net	FW	Lake, river, well & town water	m^3
Secondary Material	SM	Post-consumer recycled (PCR)	kg
Secondary Renewable Fuel	RSF	PCR biomass burnt	MJ_{ncv}
Primary Energy Renewable Material	PERM	Biomass retained material	MJ_{ncv}
Primary Energy Renewable Not Feedstock	PERE	biomass fuels burnt	MJ_{ncv}
Primary Energy Renewable Total	PERT	Biomass burnt + retained	MJ_{ncv}
Secondary Non-renewable Fuel	NRSF	PCR fossil-fuels burnt	MJ_{ncv}
Primary Energy Non-renewable Material	PENRM	Fossil feedstock retained	MJ_{ncv}
Primary Energy Non-renewable Not Feedstock	PENRE	fossil-fuel used or burnt	MJ_{ncv}
Primary Energy Non-renewable Total	PENRT	Fossil feedstock & fuel use	MJ_{ncv}
Hazardous Waste Disposed	HWD	Reprocessed to contain risks	kg
Non-hazardous Waste Disposed	NHWD	Municipal landfill facility waste	kg
Radioactive Waste Disposed	RWD	Mostly ex nuclear power stations	kg
Components For Reuse	CRU	Product scrap for reuse as is	kg
Material For Recycling	MFR	Factory scrap to remanufacture	kg
Material For Energy Recovery	MER	Factory scrap use as fuel	kg
Exported Energy Electrical	EEE	Uncommon for building products	MJ_{ncv}
Exported Energy Thermal	EET	Uncommon for building products	MJ_{ncv}

Module A1 to D4 Results Cradle to Site

Table 1 shows A1- A3 Acquisition, Transport and Manufacture then A4 Delivery and A5 Construct results.

Table 1 A1 to A5 Impact & Inventory Results/Functional Unit

Result	A1-3	A4	A5
Climate Change biogenic	-1.1E-02	-1.0E-06	-4.9E-04
Climate Change luluc	5.2E-06	1.7E-09	2.2E-07
Climate Change fossil	1.4	1.9E-02	0.06
Climate Change total	1.4	1.9E-02	0.06
Stratospheric Ozone Depletion	2.5E-08	1.7E-13	1.0E-09
Photochemical Ozone Creation	6.4E-03	1.2E-04	2.8E-04
Acidification Potential	3.1E-03	1.2E-05	1.3E-04
Eutrophication Freshwater	6.1E-08	5.6E-10	9.7E-09
Eutrophication Marine	7.1E-04	2.3E-06	3.1E-05
Eutrophication Terrestrial	1.7E-03	7.9E-06	7.4E-05
Mineral and Metal Depletion	4.8E-04	7.2E-06	2.0E-05
Fossil Depletion	0.61	2.3E-02	0.03
Water Scarcity Depletion	1.8E-02	3.0E-06	7.4E-04
Net Fresh Water Use	0.11	0.02	4.6E-03
Secondary Material	3.7E-02	2.9E-06	1.5E-03
Secondary Renewable Fuel	6.2E-02	6.7E-06	5.0E-04
Primary Renewable Material	3.4E-03	2.4E-03	3.1E-03
Primary Energy Renewable Not Feedstock	2.2	2.9E-04	0.09
Primary Energy Renewable Total	2.2	2.7E-03	0.09
Secondary Non-renewable Fuel	9.4E-03	7.4E-04	4.9E-04
Primary Energy Non-renewable Material	1.4	0.11	0.06
Primary Non-renewable Energy Not Feedstock	9.7	0.19	0.42
Primary Energy Non-renewable Total	11	0.30	0.49
Hazardous Waste Disposed	3.6E-04	3.7E-05	1.7E-05
Non-hazardous Waste Disposed	0.16	3.1E-04	0.06
Radioactive Waste Disposed	4.7E-16	1.1E-31	1.9E-17
Components For Reuse	0	0	0
Material For Recycling	1.1E-02	6.5E-06	6.1E-03
Material For Energy Recovery	2.7E-04	2.3E-07	1.1E-05
Exported Energy Electrical	0	0	0
Exported Energy Thermal	0	0	0

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Results Module B: Building Fabric and Operations

Table 2 shows B1 use, B2 maintain, B3 repair. B4 replace, B5 refurbish, B6 building energy use, B7 building water use results.

Table 2 B1 to B7 Impact & Inventory Results/Functional Unit

Result	B1	B2	B3	B4	B5	B6	B7
Climate Change biogenic	0	0	-4.3E-04	0	0	0	0
Climate Change luluc	0	0	1.7E-07	0	0	0	0
Climate Change fossil	0	0	5.2E-02	0	0	0	0
Climate Change total	0	0	5.1E-02	0	0	0	0
Stratospheric Ozone Depletion	0	0	8.0E-10	0	0	0	0
Photochemical Ozone Creation	0	0	2.3E-04	0	0	0	0
Acidification Potential	0	0	1.1E-04	0	0	0	0
Eutrophication Freshwater	0	0	9.8E-09	0	0	0	0
Eutrophication Marine	0	0	2.4E-05	0	0	0	0
Eutrophication Terrestrial	0	0	5.9E-05	0	0	0	0
Mineral and Metal Depletion	0	0	1.7E-05	0	0	0	0
Fossil Depletion	0	0	2.4E-02	0	0	0	0
Water Scarcity Depletion	0	0	5.8E-04	0	0	0	0
Net Fresh Water Use	0	0	3.60	0	0	0	0
Secondary Material	0	0	1.1E-03	0	0	0	0
Secondary Renewable Fuel	0	0	4.1E-04	0	0	0	0
Primary Renewable Material	0	0	2.9E-03	0	0	0	0
Primary Energy Renewable Not Feedstock	0	0	6.5E-02	0	0	0	0
Primary Energy Renewable Total	0	0	6.8E-02	0	0	0	0
Secondary Non-renewable Fuel	0	0	5.2E-04	0	0	0	0
Primary Energy Non-renewable Material	0	0	5.7E-02	0	0	0	0
Primary Non-renewable Energy Not Feedstock	0	0	0.37	0	0	0	0
Primary Energy Non-renewable Total	0	0	0.43	0	0	0	0
Hazardous Waste Disposed	0	0	1.6E-05	0	0	0	0
Non-hazardous Waste Disposed	0	0	5.5E-02	0	0	0	0
Radioactive Waste Disposed	0	0	1.5E-17	0	0	0	0
Components For Reuse	0	0	0	0	0	0	0
Material For Recycling	0	0	5.8E-03	0	0	0	0
Material For Energy Recovery	0	0	7.0E-06	0	0	0	0
Exported Energy Electrical	0	0	0	0	0	0	0
Exported Energy Thermal	0	0	0	0	0	0	0

Results Module C: End-of-life

Table 3 shows results for C1 demolish, C2 Transport and C3 Waste Processing C4 Disposal.

Table 3 C1 to C4 Impact & Inventory Results/Functional Unit

Result	C1	C2	C3	C4
Climate Change biogenic	-1.0E-05	-1.0E-05	0	-7.8E-07
Climate Change luluc	4.6E-11	1.4E-09	0	1.2E-09
Climate Change fossil	3E-06	0.006	0	7.4E-03
Climate Change total	3E-06	0.006	0	7.4E-03
Stratospheric Ozone Depletion	2.3E-13	1.1E-13	0	1.1E-13
Photochemical Ozone Creation	2.2E-08	6.0E-05	0	7.5E-05
Acidification Potential	1.4E-08	5.1E-06	0	2.0E-04
Eutrophication Freshwater	3.3E-13	3.1E-10	0	3.4E-10
Eutrophication Marine	4.2E-09	9.5E-07	0	1.2E-06
Eutrophication Terrestrial	7.4E-09	3.4E-06	0	4.0E-06
Mineral and Metal Depletion	3.8E-09	4.0E-06	0	4.9E-06
Fossil Depletion	2.1E-06	7.5E-03	0	9.0E-03
Water Scarcity Depletion	1.6E-07	1.4E-06	0	1.6E-06
Net Fresh Water Use	0.00	0.01	0	9.7E-03
Secondary Material	3.4E-07	2.2E-06	0	2.1E-06
Secondary Renewable Fuel	1.1E-07	5.1E-06	0	4.7E-06
Primary Renewable Material	1.4E-07	1.6E-03	0	2.0E-04
Primary Energy Renewable Not Feedstock	1.5E-05	2.0E-04	0	2.0E-04
Primary Energy Renewable Total	1.5E-05	1.8E-03	0	1.9E-03
Secondary Non-renewable Fuel	1.4E-08	4.8E-04	0	5.1E-04
Primary Energy Non-renewable Material	2.4E-06	0.04	0	0.04
Primary Non-renewable Energy Not Feedstock	4.3E-05	0.06	0	0.08
Primary Energy Non-renewable Total	4.6E-05	0.10	0	0.12
Hazardous Waste Disposed	7.1E-10	1.2E-05	0	1.5E-05
Non-hazardous Waste Disposed	1.4E-06	9.6E-05	0	1.0
Radioactive Waste Disposed	4.4E-21	8.5E-32	0	7.5E-32
Components For Reuse	0	0	0	0
Material For Recycling	1.5E-08	4.6E-06	0	4.5E-06
Material For Energy Recovery	2.9E-10	1.5E-07	0	1.6E-07
Exported Energy Electrical	0	0	0	0
Exported Energy Thermal	0	0	0	0

Results Module D: Beyond System Boundaries

Table 4 has results for benefit and loads in D1 reuse, D2 recovery and D3 recycling.

Table 4 D1 to D3 Impact & Inventory Results/Functional Unit

Result	D1	D2	D3
Climate Change biogenic	-2.0E-04	-1.9E-4	0
Climate Change luluc	1.7E-07	2.4E-09	0
Climate Change fossil	4.8E-02	0	0
Climate Change total	4.8E-02	0	0
Stratospheric Ozone Depletion	8.2E-10	5.9E-13	0
Photochemical Ozone Creation	2.3E-04	1.2E-06	0
Acidification Potential	1.0E-04	5.3E-07	0
Eutrophication Freshwater	2.2E-09	1.2E-10	0
Eutrophication Marine	2.4E-05	9.4E-08	0
Eutrophication Terrestrial	5.8E-05	6.9E-07	0
Mineral and Metal Depletion	1.8E-05	5.8E-08	0
Fossil Depletion	2.4E-02	1.7E-04	0
Water Scarcity Depletion	6.0E-04	1.8E-05	0
Net Fresh Water Use	3.7	0.11	0
Secondary Material	1.1E-03	1.7E-04	0
Secondary Renewable Fuel	4.0E-04	4.3E-05	0
Primary Renewable Material	4.9E-05	3.0E-05	0
Primary Energy Renewable Not Feedstock	6.9E-02	1.4E-04	0
Primary Energy Renewable Total	6.9E-02	1.7E-04	0
Secondary Non-renewable Fuel	2.9E-04	7.7E-06	0
Primary Energy Non-renewable Material	4.8E-02	0	0
Primary Non-renewable Energy Not Feedstock	0.37	3.1E-03	0
Primary Energy Non-renewable Total	0.42	3.1E-03	0
Hazardous Waste Disposed	1.4E-05	1.9E-07	0
Non-hazardous Waste Disposed	7.3E-03	2.0E-05	0
Radioactive Waste Disposed	1.6E-17	4.9E-21	0
Components For Reuse	0	0	0
Material For Recycling	1.9E-04	1.6E-05	0
Material For Energy Recovery	7.3E-06	6.5E-09	0
Exported Energy Electrical	0	0	0
Exported Energy Thermal	0	0	0

Interpretation Cradle to Gate A1 to A3.

The first interpretation section discusses product results cradle to gate A1 to A3.

Like most lime and cement products derived from roasting fossil limestone, admixtures have significant Global Warming Potential (GWP). Roasting limestone meal in high temperature kilns releases chemically bound carbonates from the mineral and oxides of carbon, nitrogen and sulphur from fuel combustion to air.

Figure 3 charts proprietary base mix mass versus GWP as CO_{2e} kg/kg admixture. Figure 4 charts cement mass versus GWP CO_{2e} kg/kg admixture. Together they show the cement has twice the GWP sensitivity of the next component the base mix. GWP sensitivity to sand and setting agent components were lowest.

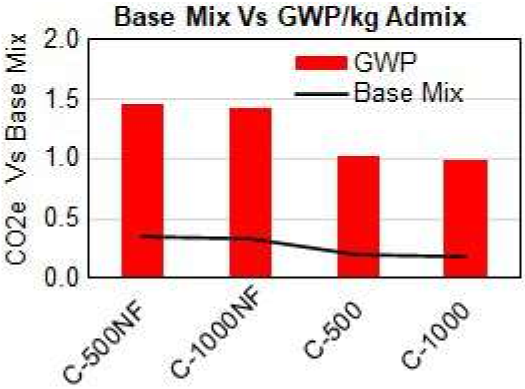

Figure 3 A1-3 Base Mix MJ Vs CO_{2e}/kg Admix

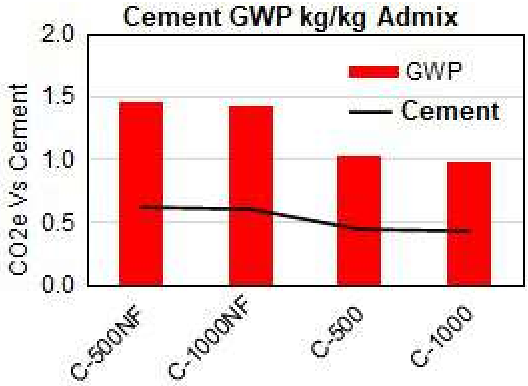

Figure 4 A1-3 Cement Vs CO_{2e}kg/kg Admix

Figure 5 charts the A1-3 abiotic depletion of access to fossil fuels (ADPff) in (MJncv) correlated to GWP CO2e kg/kg admixture. Most such fossil fuel was used in roasting limestone meal in kilns to make clinker for cement and to make lime for hydrated lime.

Interpretation Cradle to Grave and Beyond the System Boundary A1 to D3.

The second interpretation section discusses product results cradle to grave and beyond A1 to D3 Figure 6 shows highest GWP A1-A3 and insignificant A4 to C4 and beyond 60-years.

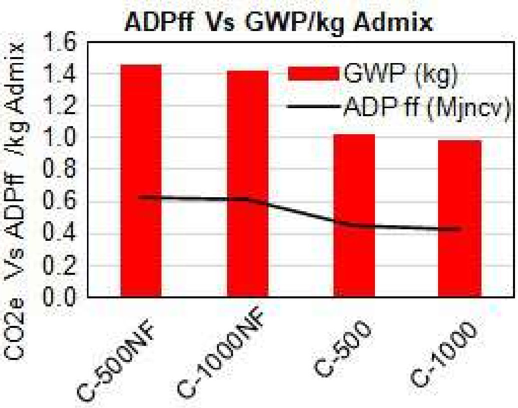

Figure 5 ADPff MJncv) Vs CO2e kg/kg A1-3

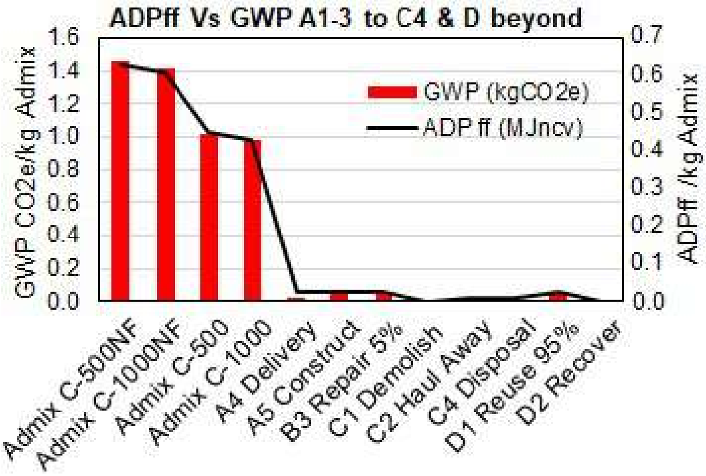

Figure 6 GWP A1 to D3/kg Functional Unit

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