

# **ECOSMART™ CONCRETE Project**

## **a concrete contribution to the environment™**

Ecosmart 混凝土计划  
混凝土对环境的贡献

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### **Low-Carbon Concrete:**

**Greener, More Economical, Higher Quality**

**低碳混凝土-更绿色, 更经济, 更质优**

**Michel de Spot, P.Eng.**  
*President & CEO,*  
**ECOSMART Foundation**

**China, Fall 2010**

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# EcoSmart™ Foundation

Non-profit organization created in 1999. 非营利组织成立于1999.  
Supported by the Government of Canada. 加拿大政府支持赞助  
Introduce technology innovations that reduce GHG emission for  
example in concrete. 介绍创新科技能减低混凝土实例的GHG排放量  
MOU signed with CABR in the context of China-Canada Climate  
Change agreement.



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# Canada China MOU on Climate Change

## 中加气候变化合作谅解备忘录



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# One tonne Clinker, one tonne CO<sub>2</sub>

50% Process 过程  
40% Fuel 燃料  
10% Electricity, 电力  
Transportation 运输



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# GHG from Cement

## World 全球

- Total emissions: 2 Gt  $\text{CO}_2$  / yr 总计排放量 : 2 Gt  $\text{CO}_2$  / 年

## China 中国

- About 1 Gt  $\text{CO}_2$  / yr or 47% of world Total 大约1 Gt  $\text{CO}_2$  / 年或 47% 的全球总量
- 40 Mt $\text{CO}_2$ /yr increase 40 Mt $\text{CO}_2$ /年 增加

New GHG reduction target for China: 40 ~ 45% by 2020

中国新GHG减少目标 : 40 ~ 45% 于2020

# GHG Reduction Strategies in cement manufacturing

## 水泥制造的GHG减少目标

1. Decrease energy intensity    **减少能源强度**
  - diminishing returns    **缩减报酬**
2. Increase alternative fuel    **增加替代燃料**
  - only biofuels for CC offsets    **唯一的生物燃料为抵消cc**
3. Increase the use of SCM (\*)    **增加SCM的使用**
  - pre-blended at the plant    **在设备预先混合**
  - added in the concrete mix    **在混凝土拌合料里加入**

(\*) Supplementary Cementing Material    **辅助胶凝材料**

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# SCM



Fly Ash

Ground Granulated Blast  
Furnace Slag



# SCM

Natural Pozzolan



Metakaolin



# SCM

SCM	Source	Type	Activity	Cost	Availability
Fly Ash	Power	Pozz	Med	Med-low	High
GGBFS	Steel	Hydro	High	Med	Med
Micro Silica	Silica	Pozz	Very High	Very High	Low
Pozzolan	Geo	Pozz	Low	Low	Regional
Metakaolin	Oil / Geo	Pozz	Very High	High	?
Limestone	Geo	Filler	n/a	Low	High

# Portland Cement Standard - China

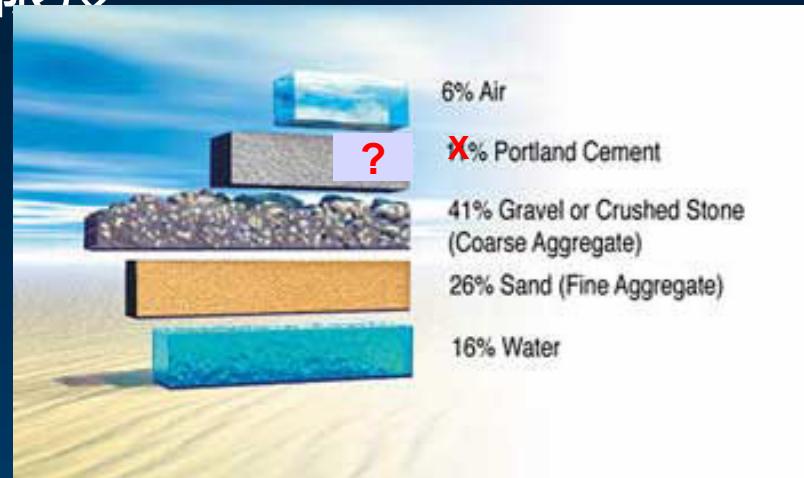
<b>Portland Cement</b>	P.I	<b>100</b>	---	---	---	---
	P.II	<b>≥95</b>	<b>≤5</b>	---	---	---
		<b>≥95</b>	----	----	----	<b>≤5</b>
<b>Ordinary Portland Cement</b>	P.O	<b>≥80, &lt;95</b>	<b>&gt;5, ≤20</b>			----
<b>Portland Slag Cement</b>	P.S.A	<b>≥50, &lt;80</b>	<b>&gt;20, ≤50</b>	----	----	----
	P.S.B	<b>≥30, &lt;50</b>	<b>&gt;50, 70</b>	----	----	----
<b>Portland Pozzolana Cement</b>	P.P	<b>≥60 , &lt;80</b>	----	<b>&gt;20, ≤40</b>	----	----
<b>Portland Fly ash Cement</b>	P.F	<b>≥60, &lt;80</b>	----	----	<b>&gt;20, ≤40</b>	----
<b>Composite Portland Cement</b>	P.C	<b>≥50, &lt;80</b>	<b>&gt;20, ≤50</b>			

# EcoSmart Concrete Objectives

EcoSmart 混凝土目标

To minimize GHG “signature” of concrete  
by optimizing replacement of Portland cement with SCM  
while improving or maintaining  
最有效地進行替代Portland混凝土与SCM当改善或维持  
缩小GHG 混凝土特征信号至最小限度

- Cost
- Performance
- Constructability



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# 50% FA



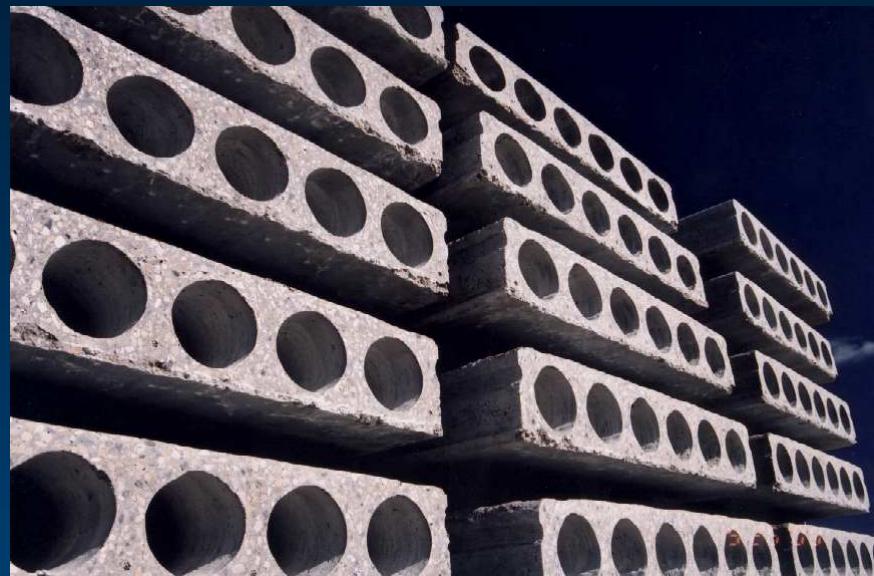
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## CONCRETE

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50% fly ash

# Precast Concrete



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# Bayview High Rise Building

Element	Min. 28 Day Strength (mPa)	% flyash replacement (Ledcor Standard)	% flyash replacement (Actual)	W/CM
Parking Slabs & Slab Bands	35	15	33	0.40
Slab on Grade Interior Parking	25	20	20	0.50
Slab on Grade Exterior	32	20	20	0.45
Core Footing	30	40	45	0.50
Other Footings	25	40	45	0.50
Shear Walls & Columns				
<i>Foundation to 8th Floor</i>	40	15	33	0.45
<i>8th to 12th Floor</i>	35	15	33	0.45
<i>12th to 16th Floor</i>	30	20	33	0.45
<i>16th Floor to Roof &amp; Other Walls</i>	25	20	33	0.45
Tower Slabs	25	15	15 to 25	
Toppings & Housekeeping Pads	20	15	45	

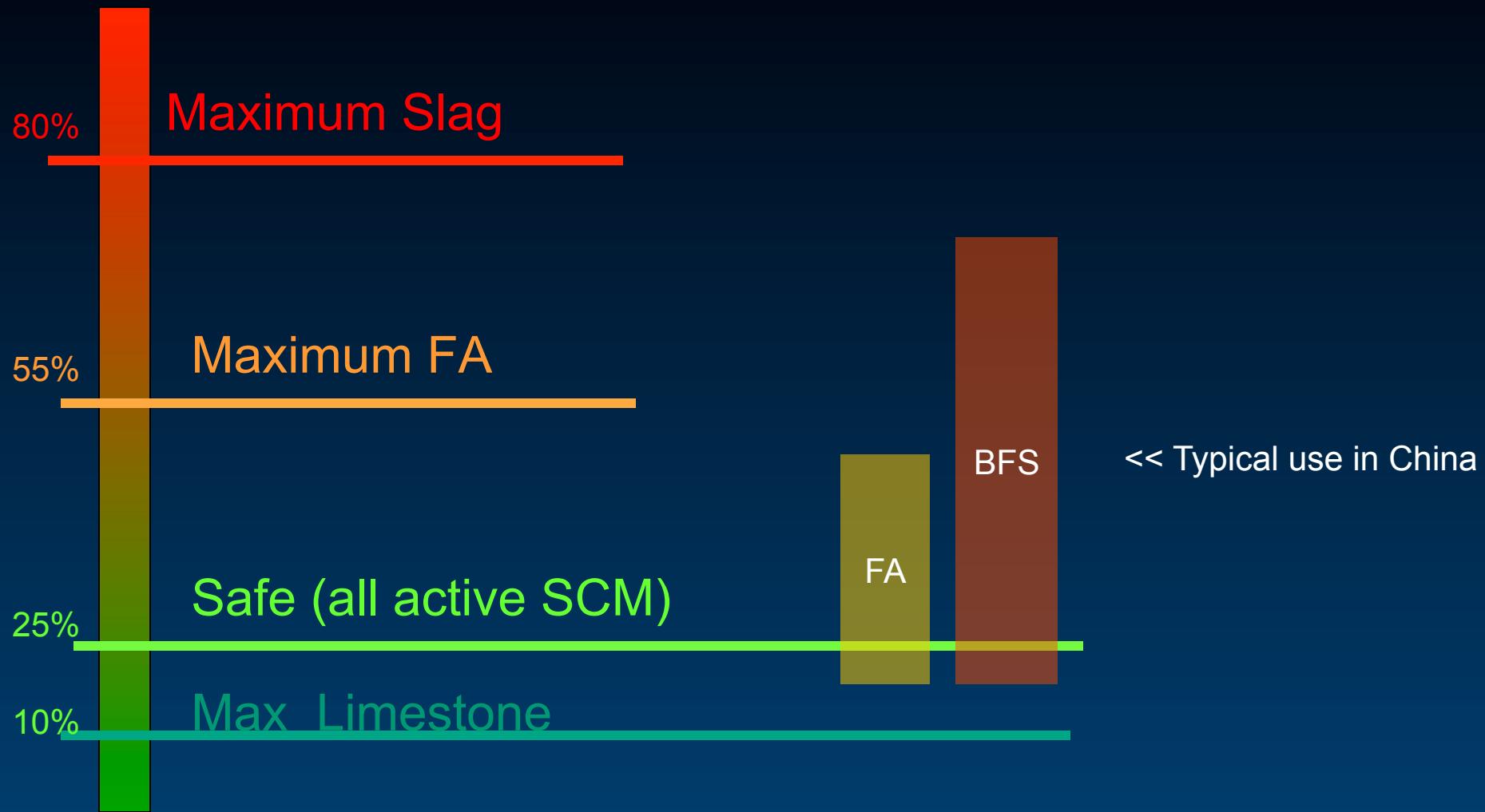


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# Replacement level



# Concrete Parameters

## Material

Type of SCM: FA, GGBFS, SF, other

Cost, Availability, distance

## Technical

Type of element: slab, walls, footings, ..

**Strength:** Stripping, 28d, 56d

**Durability**, resistance to scaling, exposure

Curing, carbonation

**Standards**, liability

## Construction

Placing, finishing, forms, curing

Setting time: Stripping and finishing

Architectural aspect : Color, texture, finish

## Environment

GHG Signature

Waste reduction

Expected lifespan

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# Industry decision-makers

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## Supply

- Cement Manufacturers
- Ready-Mixed Concrete Producers
- SCM producers / suppliers

## Design

- Developers
- Architects
- Structural Engineers
- Material engineers & test labs
- Code officials

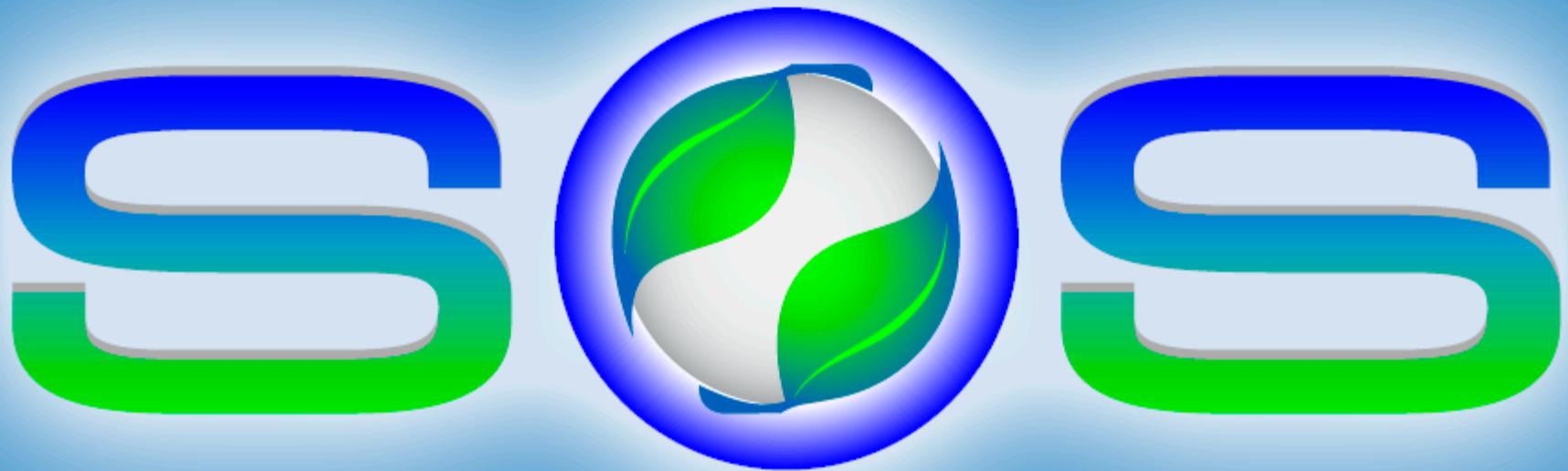
## Build

- Contractors
- Sub-trades: Concrete placers

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**Supplementary Cementing Materials Optimization System**

# The SOS Consortium



Supplementary Cementing Materials Optimization System



Non-profit organization promoting the increased use of SCM  
in "Green concrete"



**SIMCO**  
Technologies inc.

**sos**  
**Consortium**

**Software Development Company**  
Concrete Infrastructure Management, Engineering  
Life-Cycle Cost Analysis



**20 Canadian organizations**  
Cement producers, contractors, architects, engineers,  
public organizations

# The Challenge

Use of SCM has been impeded by a number of different reasons:

- Lack of information on the pros and cons of SCM
- Improper training
- Regulations
- Bad experience
- Market inertia



*The successful use of SCM in concrete rests on knowledge sharing!*

# SOS - Our Mission



Supplementary Cementing Materials Optimization System

To develop a user-friendly web-based software that will facilitate « green concrete » by sharing information on the successful use of SCM.



# The SOS Databases



Supplementary Cementing Materials Optimization System

User: jbethier      Logout

Structure: Industrial building      Help

Location: Quebec      Change Password

Connection Time: 00:01:03      Preferences

Analysis Type      Project Information

Select project: New Project 1

Project name: New Project 1

Project reference (facultative):

Location: Quebec Montreal

Schedule: 2/2/2010 4/30/2010

Structure: Industrial building

Element: Slab on grade

Manure or silage gases and liquids:

Municipal sewage or industrial effluent:

Exposure:  Exterior  Interior

Chloride exposure  Sulphate exposure

Structurally Reinforced  Saturated

Potentially reactive aggregate  Immersed

Montreal Weather Statistics

Legend: Daily average temperature (Grey), Daily max temperature (Red), Daily min temperature (Blue), Relative humidity (Green)

Graph showing Temperature (°C) and Humidity (%) from September to September. A vertical red shaded area covers January through April, labeled 'Berlin' at the bottom.

Save Project Save Project As... SCM Increase Mode Previous Next

# The SOS Databases



Supplementary Cementing Materials Optimization System



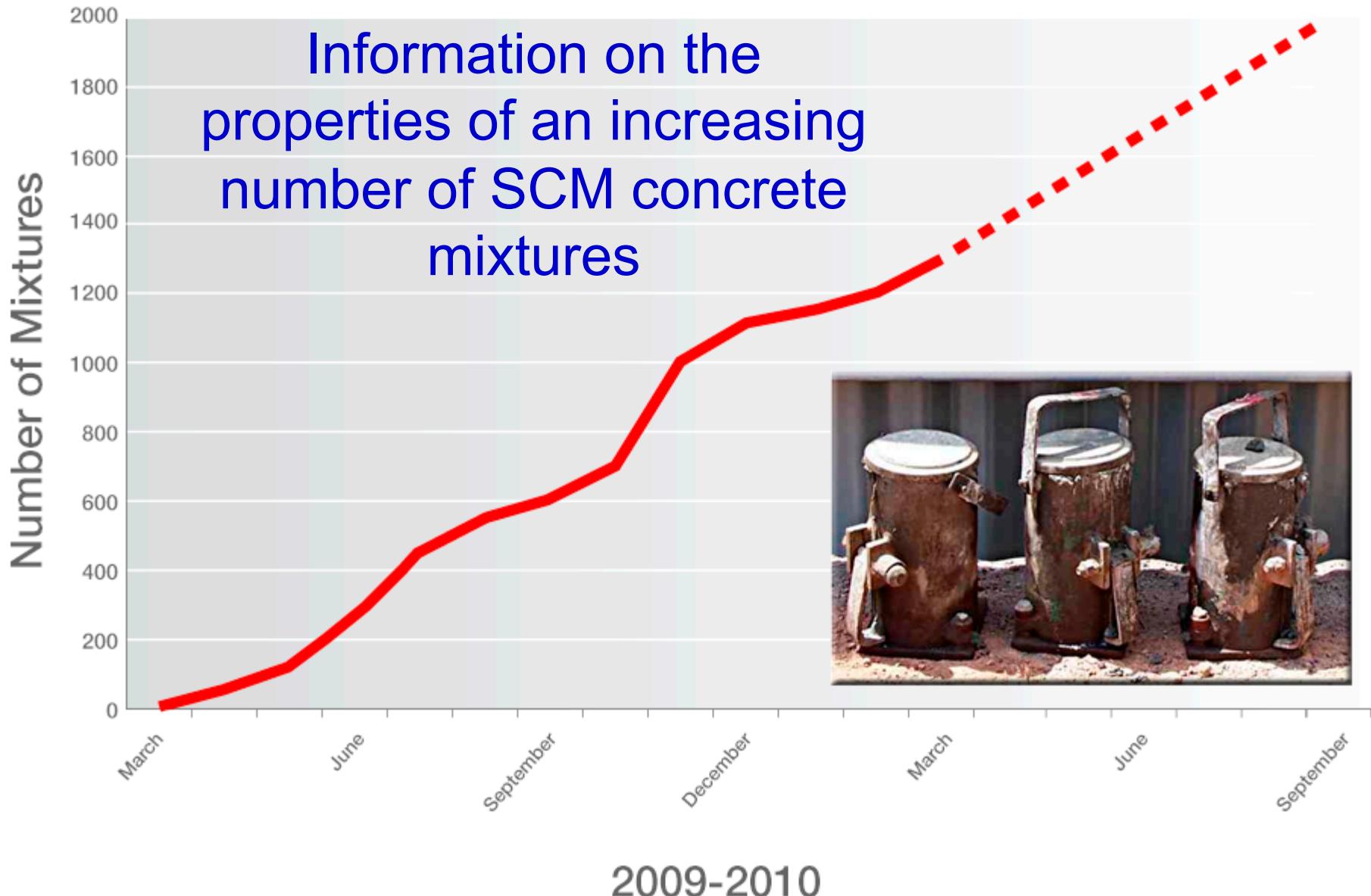
Information originating from more than 25 different technical documents published by different Canadian organizations



# The SOS Databases



Supplementary Cementing Materials Optimization System



# A User-Friendly Interface



Supplementary Cementing Materials Optimization System

User: jbethier  
Structure: Industrial building  
Location: Quebec  
Connection Time: 00:00:28

**SOS**  
Supplementary Cementing Materials Optimization System

Logout Help Change Password Preferences

Analysis Type Project Information Codes & Standards Specifications

Mix properties Strength and schedule Durability Cracking Curing Visual aspect and finish Codes Default Values:

**Mix characteristics**

Cement type	<input type="text"/>		
Projected SCM class	Type F Fly Ash		
Water-binder ratio	Min <input type="text"/>	Max <input type="text"/> 0.37	
SCM replacement level	Min <input type="text"/> %	Max <input type="text"/> 40	%
Paste content	Max <input type="text"/> %		
Max aggregate size	<input type="text"/> mm		
Sand/aggregate ratio	Min <input type="text"/>	Max <input type="text"/>	

**Fresh concrete properties**

Pumpability required	<input type="radio"/> Yes	<input checked="" type="radio"/> No
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Save Project Save Project As... SCM Increase Mode Previous Next

# Multiple User Modes

Optimum SCM Volume

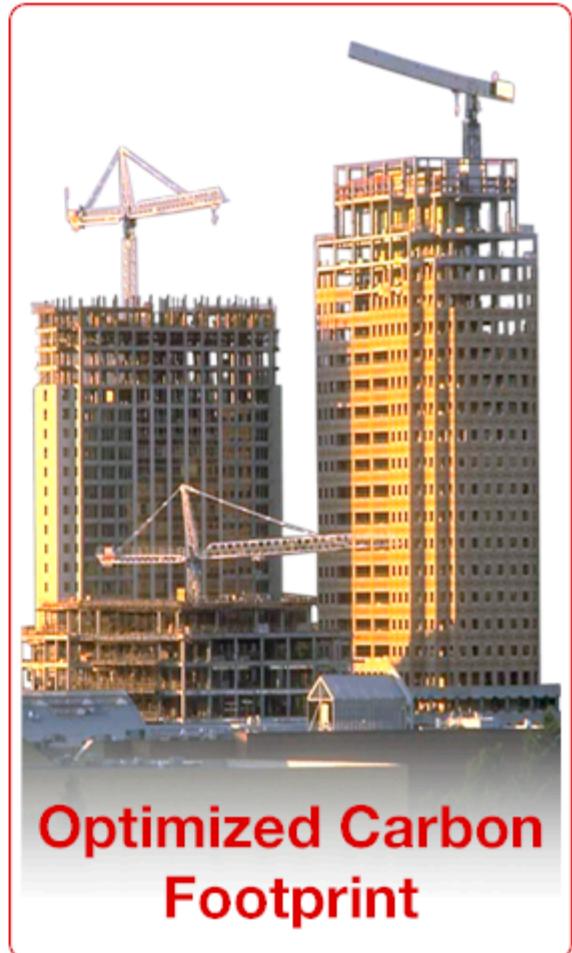
Compliance with Specifications

Theoretical Strength Development

GHG Emission Reduction

Cost Impact

Appearance



**Optimized Carbon  
Footprint**

# Output – Expert Guidance



Supplementary Cementing Materials Optimization System



Literature Survey



Expert Opinions



Field Experience



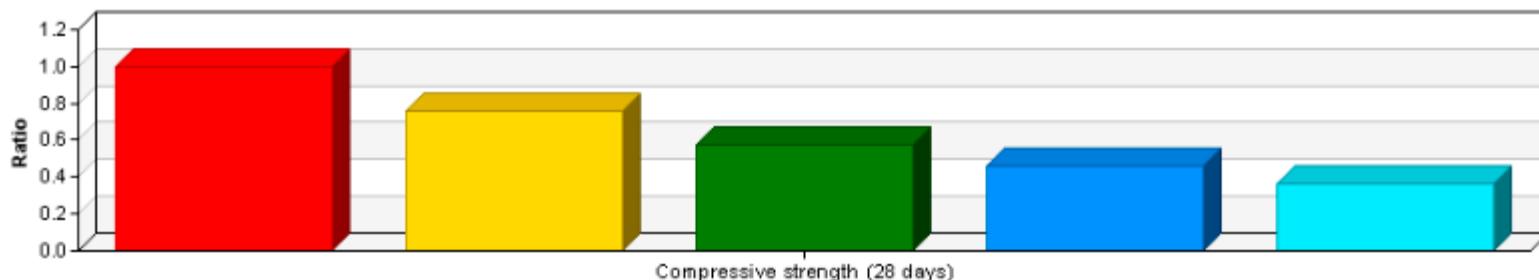
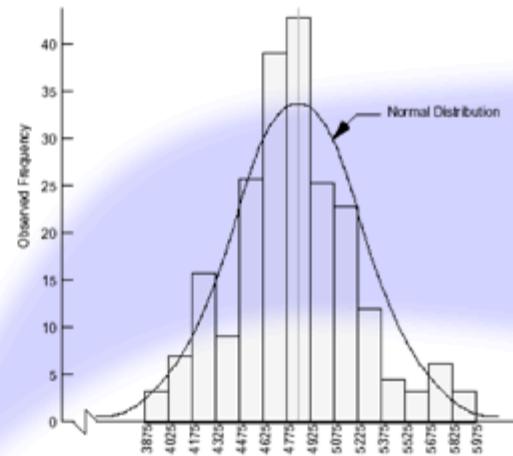
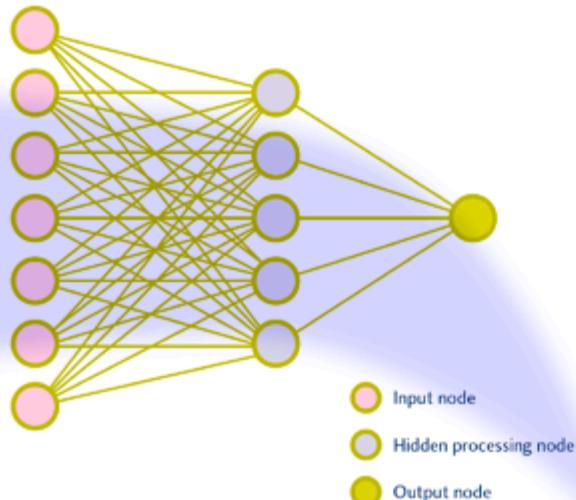
Expert Guidance, e.g.:

« *Cement replacement by fly ash may cause bleeding.  
This can be overcome by a reduction of the water-binder ratio.* »

# Output - Quantitative Data



Supplementary Cementing Materials Optimization System



Scenario 1  
(Référence) :  
SCM % : 0

Scenario 2 :  
SCM % : 20

Scenario 3 :  
SCM % : 35

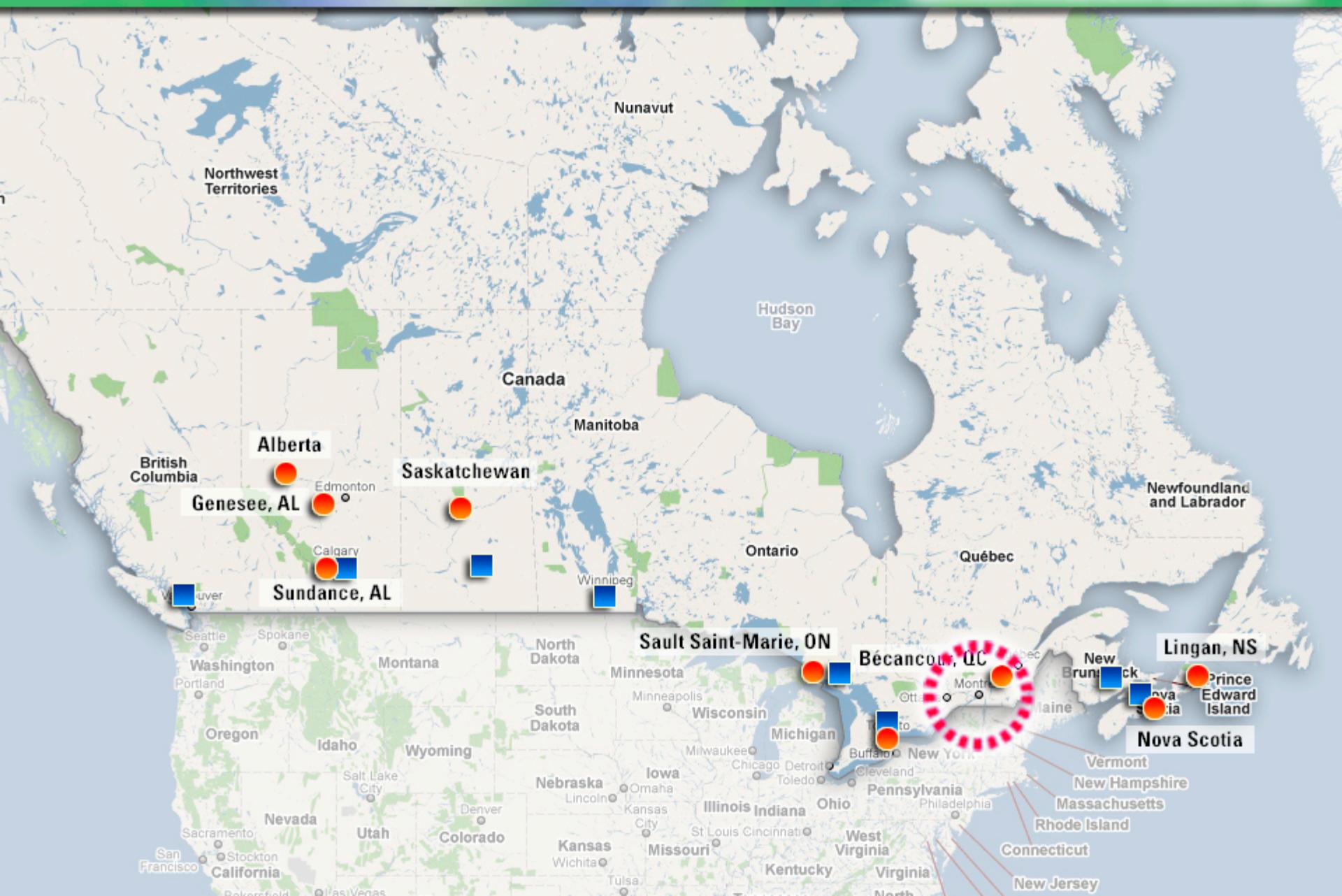
Scenario 4 :  
SCM % : 55

Scenario 5 :  
SCM % : 70

# Output - Source Location



Supplementary Cementing Materials Optimization System



# The STADIUM® Solution

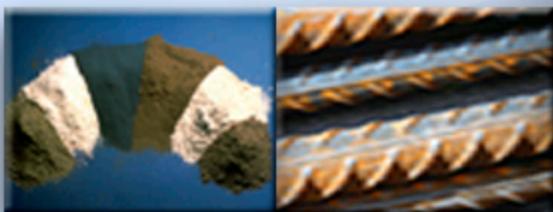


Supplementary Cementing Materials Optimization System

## Local Exposure Conditions



## Properties of Materials



## Protection Solutions



## Chemical Degradation



## Steel Corrosion



## Moisture Emission

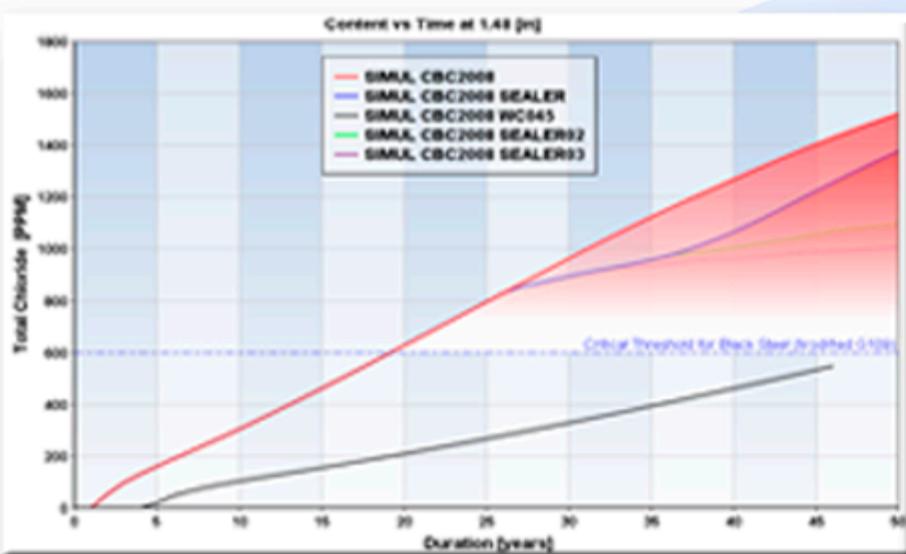


# The STADIUM® Solution

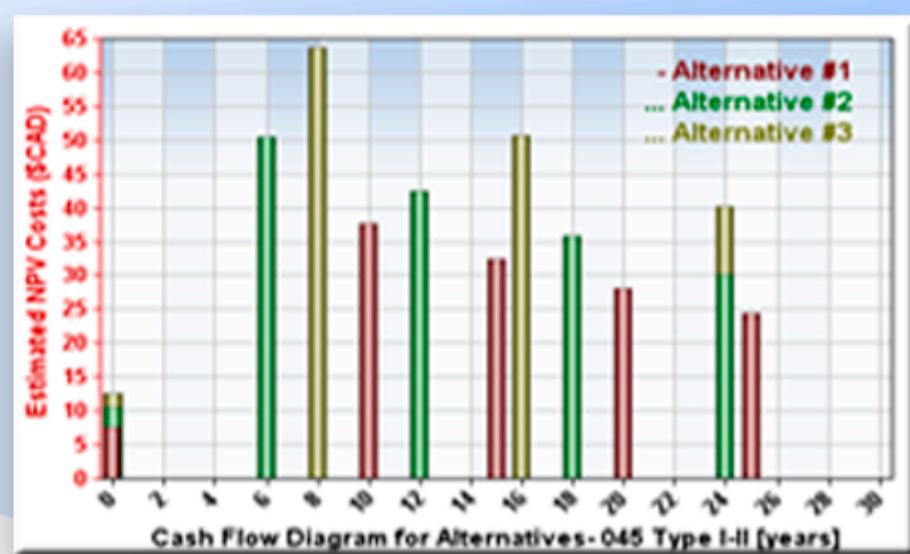


Supplementary Cementing Materials Optimization System

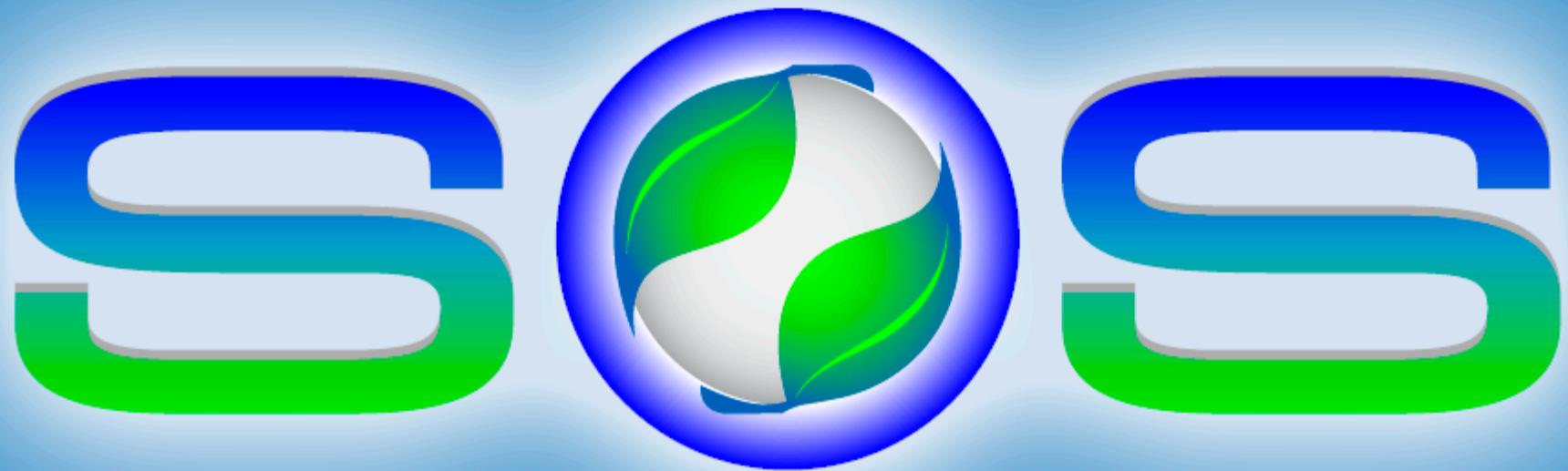
## A comprehensive software solution for engineers!



Optimum Technical Solution



Reliable Cost Control



**Supplementary Cementing Materials Optimization System**

**DEMO PRESENTATION**