

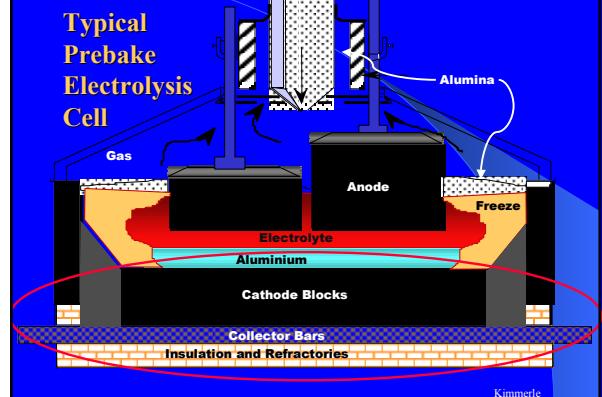
CAISiFrit, A New Alternative Supplementary Cementitious Material

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CRIB

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sur les infrastructures en béton

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- Spent pot liner (SPL) is a waste from the aluminium smelters

Spent Pot liners

The largest environmental problem of the aluminium industry

SPL is hazardous waste:

It contains fluorides and cyanide

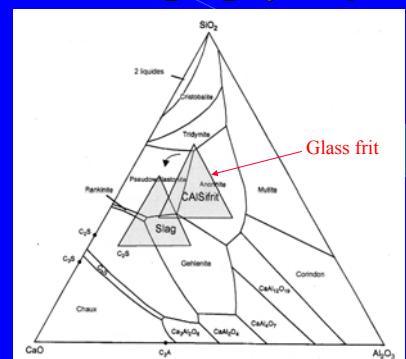
100 tonnes of aluminium

→ 2 tonnes of SPL

Pyroprocessing

1- Optimization: Chemical composition

CaO-SiO₂-Al₂O₃ Diagram



Pyroprocessing

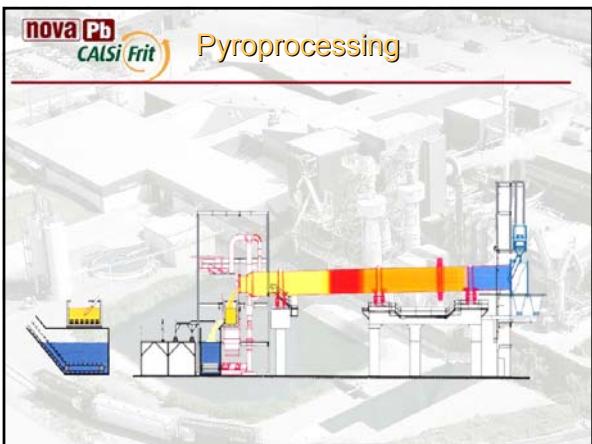
1- Optimization: Chemical composition

2- Thermal treatment in a rotary kiln

Thermal treatment



Pyroprocessing



Pyroprocessing

1- Optimization: Chemical composition

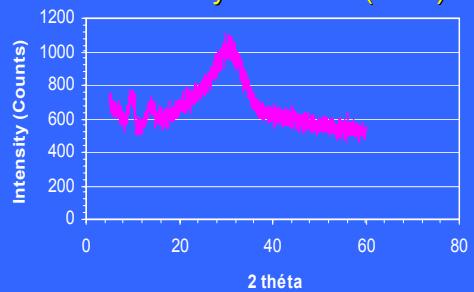
2- Thermal treatment in a rotary kiln

3- Quenching: Vitrification

CALSiFrit = Glass frit (GF)



X Ray diffraction(XRD)



Pyroprocessing

- 1- Optimization: Chemical composition
- 2- Thermal treatment in a rotary kiln
- 3- Quenching
- 4- Grinding

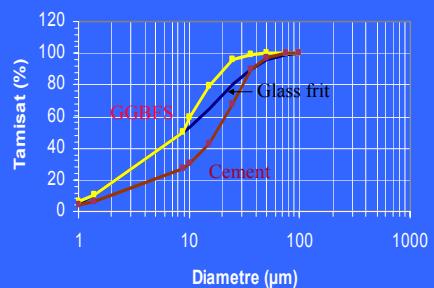
Ground glass frit
400 kg/m²



GF Chemical composition

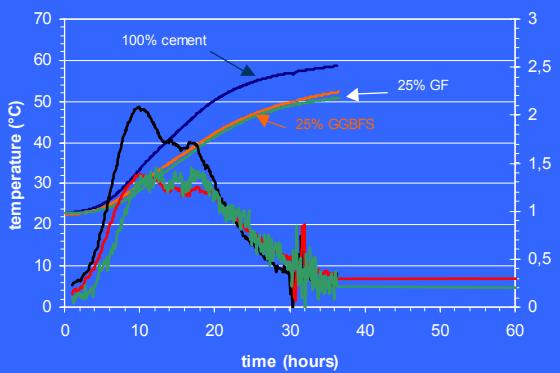
Oxydes	Pourcentage (%)
SiO ₂	31.7
Al ₂ O ₃	23.4
Fe ₂ O ₃	3.4
CaO	14.6
MgO	0.76
CaF ₂	9.4
K ₂ O	1.0
Na ₂ O	9.4
C	0.4

Particle size distribution

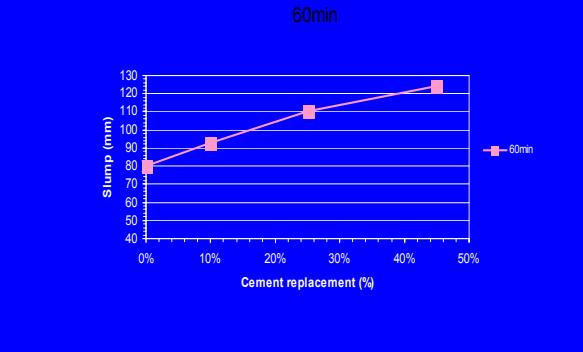


•Fineness: 407 m²/kg

Calorimetric analysis



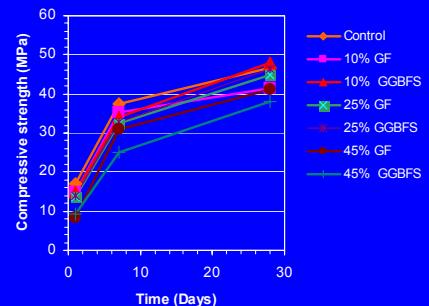
Mini slump test



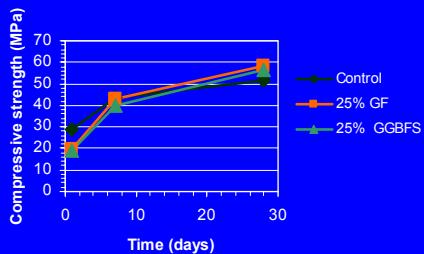
Mortars activity index (ASTM C311)

Properties		GF
Activity index (%min)	7d	92
	28d	100

Compressive strength W/B = 0.45

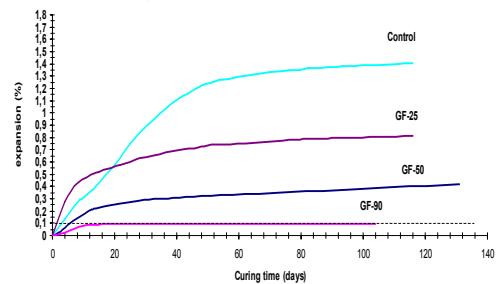


Compressive strength W/B = 0.35, SP= 0.8%



- Alkalis-silica reaction (Spratt)

- ✓ ASTM C1260 (accélerated test on mortar bars in 1N NaOH solution at 80°C)

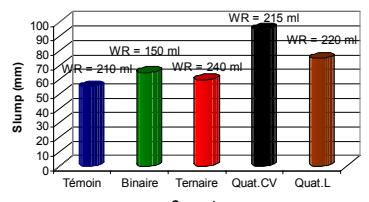


CONCRETE

- W/B = 0.45 ; 0.35
- Binary blend (PC + GF)
- Ternary (PC + SF+ GF)
- Quaternary (PC + SF + GF + CV or S)

Concrete W/B = 0.45

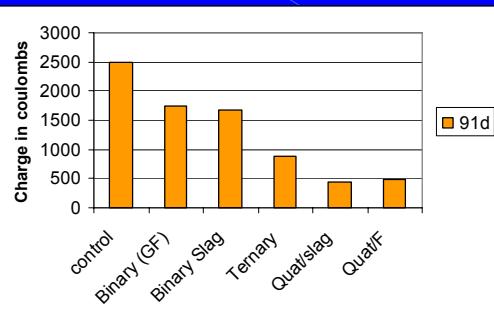
Slump after 60 minutes



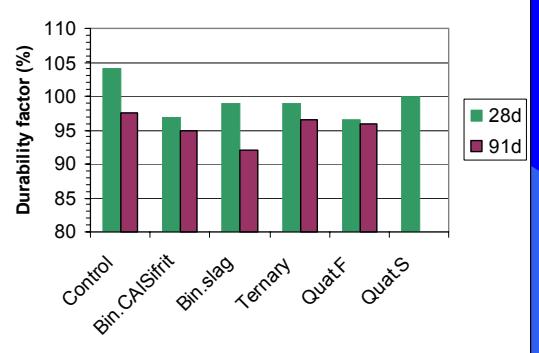
Setting time

Concrete	Initial	Final
Control	7h30	8h30
Binary	6h50	8h30
Ternary	8h10	9h40
Quat.F	10h50	12h30
Quat.S	11h00	12h35

Chloride ions permeability



Durability factor

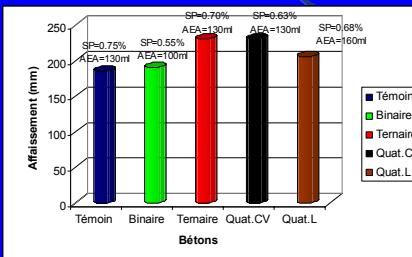


Scaling resistance

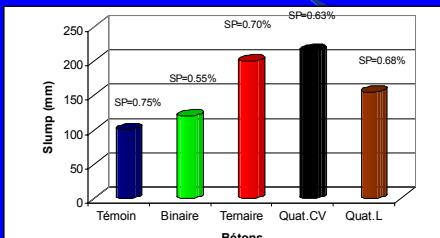
Concrete	Scaled mass (g/m ²)	Number of cycles	Code
Témoin	590.70	50	3
Binaire CF	3078	56	1B
Ternaire	2201.55	18	6
Quat.CV	3996.04	11	6
Quat.L	3090.50	5	6

High performance concrete
W/B = 0.35

Affaissement à 10 minutes



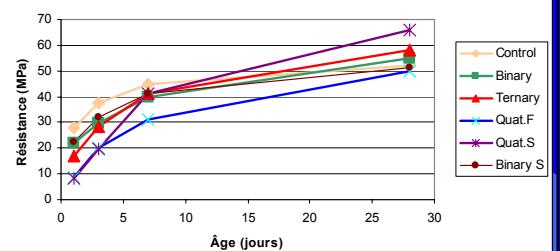
Slump after 60 minutes



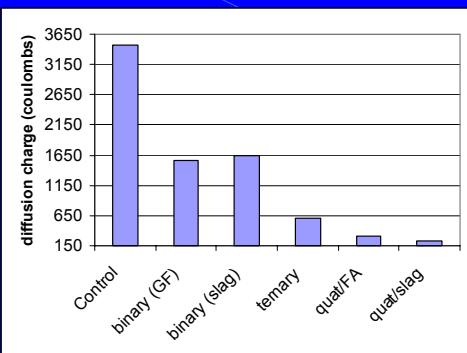
Setting time

Concrete	Initial	Final
Control	6h10	7h20
Binary	6h45	8h10
Ternary	7h45	9h05
Quat.F	11h00	12h40
Quat.Slag	8h10	9h30

Compressive strength

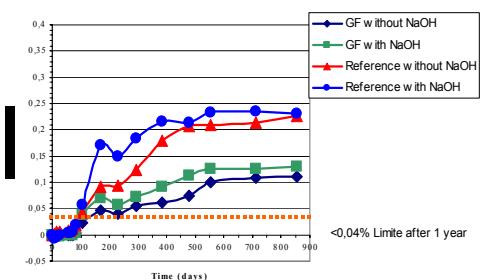


Chloride ions permeability

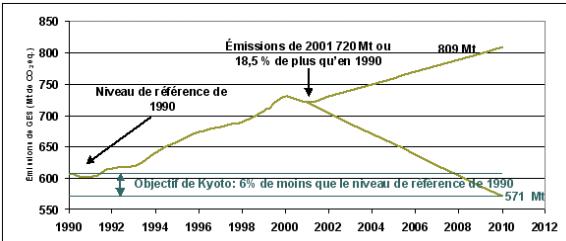


- Alkalis-silica reaction (Spratt)

✓ CSA A23.2-14A (test on concrete prisms in 1N NaOH solution at 38°C)



Greenhouse Gas Emissions



- Reduction in CO₂ emission:

-25 % cement replacement by CAISiFrit =
12% total effective CO₂ reduction

In situ Concrete for CSA approval process

Alcoa Project



Demix Project



Demix Project



Nova Pb Project



Nova Pb Project



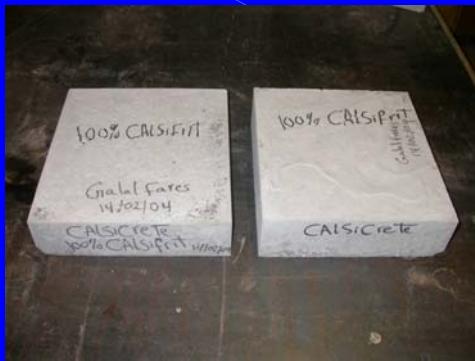
Glass Frit, A Cementitious Binder



Figure 25 100% Alkali-activated glass frit mortar

Figure 26 Alkali-activated 80% glass frit mortar with 20% red mud replacement

Glass Frit, A Cementitious Binder



Conclusion

- Very good effect on water demand
- Very good mechanical performance (similar to GGBFS)
- Increase cement replacement
- Excellent product for sustainable development
- Reduction in CO₂ emission