

Ciment Fondu®

Construction Application

Updated 06/03/2007

1 General characteristics

- ◆ A rapid hardening cement allowing concrete to be put into service between 6 and 24 hours after placing
- ◆ Excellent resistance to chemical attack, $\text{pH} \geq 4$
- ◆ Ideal for high temperature applications
- ◆ Particularly suited to areas subject to abrasion
- ◆ Used mixed with ortland cement, it allows settlement between 3 and 30 minutes according to the dosage.

Ciment Fondu® is a cement based on calcium aluminates, rather than calcium silicates which are the basis of Portland cement. This difference gives Ciment Fondu® properties ideally suited to specific applications which complement the traditional uses of Portland cement.

Ciment Fondu® has a setting time similar to that of Portland cement, but is very rapid hardening. Concretes and mortars achieve a high early strength allowing fast tripping of formwork, and a rapid return to service (e.g. road repairs) normally between 6 and 24 hours after placing.

Ciment Fondu®, unlike Portland cement, does not release free lime during hydration. This means that concretes with low porosities (low Water.Cement ratio) have an excellent resistance to chemical attack, $\text{pH} \geq 4$, from a wide range of aggressive substances. Furthermore Ciment Fondu® is ideally suited for heat resistant and refractory concretes.

Ciment Fondu® concretes and mortars formulated to achieve high strength and low porosity exhibit better abrasion and wear resistance. Even greater performance can be achieved by the selection of appropriate aggregates such as Alag®. Thus, it is an ideal choice for applications where the concrete is subject to abrasion : industrial floors, flume linings, piers, discharge and transfer areas, spillways, etc. Ciment Fondu® is also an accelerator for Portland cement. Application include renders, screeds and grouting materials. Ciment Fondu®/Portland cement mixes should not be used for structural concrete.

Ciment Fondu® is produced and controlled within a quality management system that is certified according to ISO 9001.

2 Spécifications

The properties of Ciment Fondu® produced in Europe conform to the requirements defined in the norm EN 14647 : "Calcium Aluminate Cement".

The *specification limits* indicated are determined with an acceptable quality level (AQL) of 2.5 % defined in the standard ISO 3951.

The *strict specification limits* define the absolute limits of product conformity applicable for individual values.

The EN specification limits are conformed with the requirement defined in the norm EN 14647.

The *usual range* represents typical values of production.

Chemical composition

Main constituents (%) :

	Usual range	Specification limit
Al ₂ O ₃	37.5 - 41.0	> 37.0
CaO	35.5 - 39.0	< 41.0
SiO ₂	3.5 - 5.5	< 6.0
Fe ₂ O ₃	13.0 - 17.5	< 18.5
MgO	-	< 1.5
TiO ₂	-	< 4.0

Other constituents (%) :

	Strict specification limit
S (as sulphide ions)	≤ 0.1
Cl (as chloride ions)	≤ 0.1
Na ₂ O + 0,659 K ₂ O (%)	≤ 0.4
SO ₃	≤ 0.5

The chemical characteristics of Ciment Fondu® have been determined according to the following:

- ◆ EN 196-2 : Methods of testing cement - Chemical analysis of cement.

Fineness

	Usual range	Specification limit
specific surface Blaine(cm ² /g)	2850 - 3450	> 2700

- Determined in accordance with EN 196-6: Methods of testing cement - Measurement of fineness.

Neat paste setting time

	Usual range	Specification limit
Initial set (min)	180 - 300	> 120
Final set (min)	210 - 330	< 480

- Determined in accordance with EN 196-3: neat cement paste at standard consistency; mechanical mixing; Vicat test equipment using 300g weight; temperature 20°C; relative humidity > 90%.

Mechanical strength

Compressive strength, MPa		
Age	Usual range	Strict specification limit
6 h	35 - 50	> 30
24 h	60 - 80	> 50

- Composition of mortar according to EN 14647: 1350g of sand, 500g of calcium aluminate cement, 200g of water
- Test conditions according to EN 196-1: test prisms 40x40x160mm; temperature 20°C; prisms cured at >90% relative humidity for 24 hours (NF standard) or 6 hours (BS standard), followed by immersion in water.

3 Additional information

This information is given for guidance only.

- Principal mineralogical phase* : CA
- Secondary phases* : C₁₂A₇ C₂S C₂AS C₄AF
- Bulk density : 1100 kg/m³
- Specific gravity : 3,2 - 3,3 g/cm³
- Pyrometric cone equivalent (on neat cement paste): 1270 - 1290 °C
- Heat of hydration
 - 6 h : 340 kJ/kg
 - 24 h : 445 kJ/kg
 - 5 days: 445 kJ/kg

* C=CaO, A=Al₂O₃, S=SiO₂, F=Fe₂O₃

Beyond the minimal requirement of the standard EN 14647, the French production benefits from controls and complementary requirements such as defined in the reference frame NF 002.

Workability - French production

	Specification limit
Spread after 15 min (%)	> 30

The workability of Ciment Fondu® has been determined by measuring the flow properties using the ASTM C230 flow table. The test is carried out using a standard siliceous sand mortar.

- Composition of mortar according to EN 14647: 1350g of sand, 500g of calcium aluminate cement, 200g of water
- Test carried out with 25 shocks after 15 min retained in cone mould, d₁ (diameter of base) = 100mm.
%of flow = d₂ (mm) - d₁ (mm).

Mortar setting time - French production

	Usual range	Specification limit
Initial set (min)	130 - 200	> 120
Final set (min)	140 - 220	< 240

- Composition of mortar to EN 14647 : 1350g of sand, 500g of calcium aluminate cement, 200g of water
- Preparation according to EN 196-1
- Measurement according to NF P15-431: Vicat test equipment as EN 196-3 but using a 1000g test weight, temperature 20°C, samples immersed in water or cured at > 90% relative humidity.
- Final setting measured in accordance to NF P15-330 : the Vicat needle no longer penetrates the mortar.

Mechanical strength - French production

Mechanical strength in MPa		
Age	Modulus of rupture strict specification limit	Compressive strength strict specification limit
6 h	> 4	> 30
24 h	> 5	> 50
28 days	> 6.5	> 60

- Composition of mortar according to EN 14647 : 1350g of sand, 500g of calcium aluminate cement, 200g of water
- Test conditions according to EN 196-1: test prism 40x40x160mm, temperature 20°C, prism cured at >90% relative humidity for 24 hours (NF standard) or 6h (BS standard), followed by immersion in water.

4 Storage and shelf life

Like with all hydraulic binders Ciment Fondu® must be stored in dry conditions, off the ground. In this case, Ciment Fondu® will retain its properties for up to six months. In many instances properties are retained for over one year.

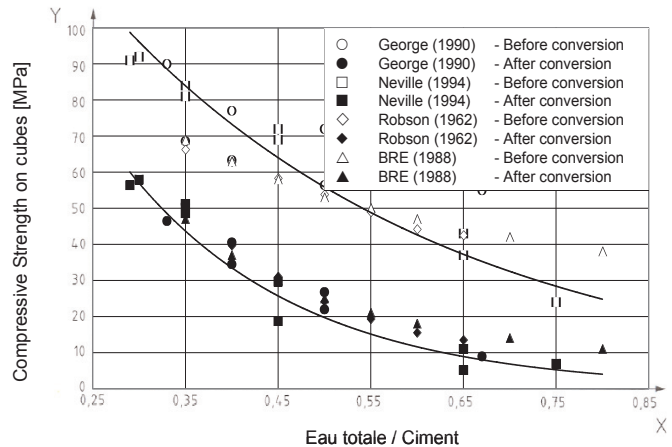
5 Durability and Conversion

As with any hydraulic binders, the long term strength of Ciment Fondu® concrete depends on the mix design and the constituents, in particular the Water/Cement ration and the nature of aggregate.

A specific feature of CimentFondu® concrete is the phenomenon of conversion. This phenomenon is characterised by a high temporary strength which diminishes over time to lower long term strength. When the conversion of the hydrates is completed, the long term strength will be stable. Only the strength after conversion should be considered for design purpose.

An indication, it can be estimated that Ciment Fondu® concrete produced according to modern codes of practice ($W/C \leq 0.40$) with good quality aggregates will achieve a compressive strength, after conversion, of around 25 MPa when measured on cylinders or around 30 MPa when measured on cubes.

It is possible to obtain higher strength by modifying the mix design (reduction of Water/Cement ration, use of workability aids/plasticizers as well as the nature and grading of aggregates). The influence of Water/Cement ratio on the compressive strength, before and after conversion, is illustrated by the following graph from Appendix A of EN 14647 Standards - Calcium aluminate cement - Composition, specifications criteria.



For construction applications, it is recommended to use a minimum cement content of 400 kg/m³ of Ciment Fondu® with a Water/Cement ratio of ≤ 0.40 .

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