Basic properties
Durability

The originality of the mineralogical composition of *Prompt* natural cement is due to low-temperature firing (600 to 1,200°C) of marl.
Two major families of minerals form:
- aluminates and sulfoaluminates of calcium, which after hydration are responsible for setting and early hardening as soon as setting is complete,
- essential silicates in the form of belite (C2S) present in large quantities (40 – 60%).

Long-term strength:

In contrast to alite (C3S), found in abundance in Portland cements, belite hydrates slowly, over several months and years.

Increased strength therefore accumulates in two phases:
- rapid hardening during the first hours due to hydration of aluminates,
- followed by a slow increase in strength over a period of several months and years, thanks to hydration of the belite (**Figure 1**)

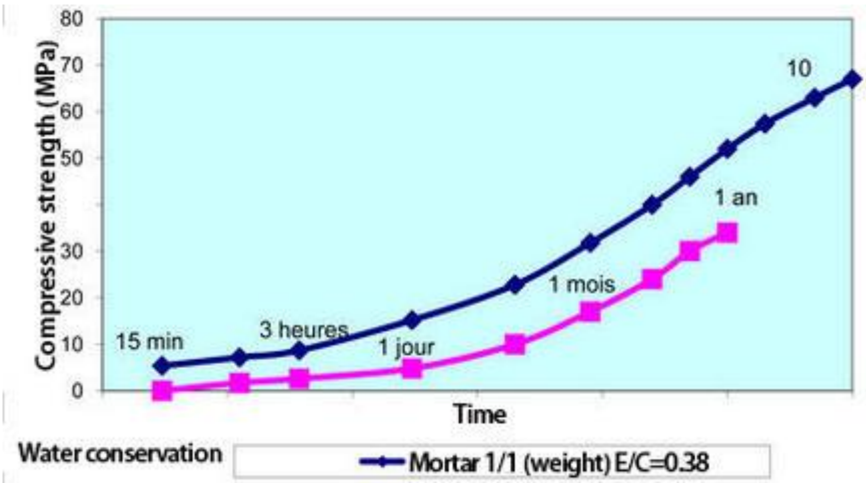

Figure 1

The dicalcium silicate adds hydration potential over time, along with the possibility of "self-repair" of any irregularities, such as micro-cracking, at a very early stage.
This makes it a very important contributor to durability.

Waterproofing:

This slow hydration of belite raises the potential for the hydrate to develop over time, and also allows the formation of low permeability (**Figure 2**). After one month, the permeability is the same as for a CEM II 42.5 N mortar after three months. After six months, with a high dosage, the permeability coefficient drops sharply to achieve very low values at 12 months that are similar to those of high performance cements.

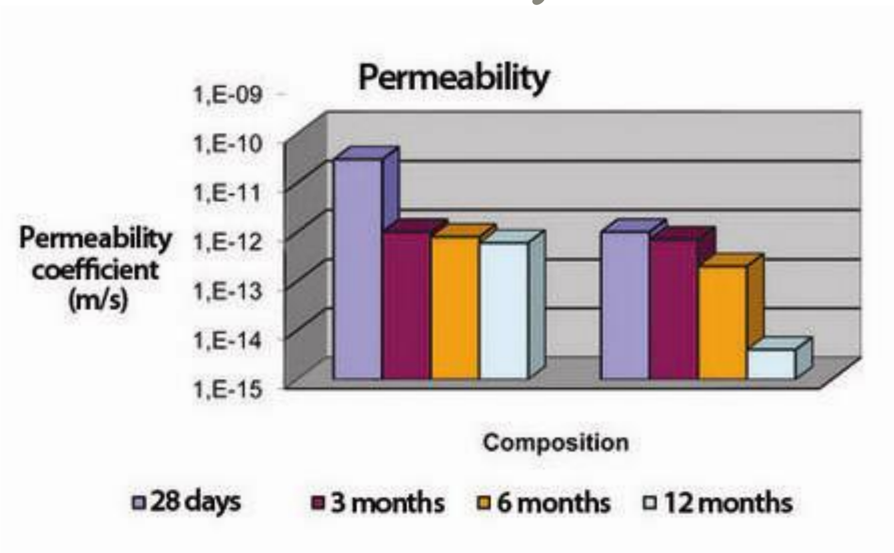

Figure 2

This property is confirmed by observing *Prompt* natural cement mortar under scanning microscope, which reveals an often compact, closed and very low porosity texture.

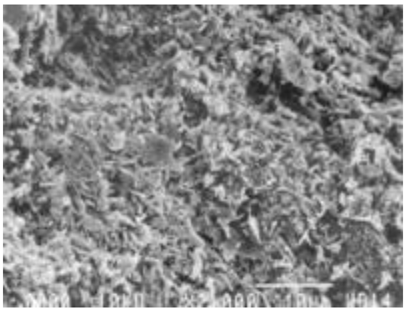

Figure 3

Appearance of *Prompt* natural cement paste in a mortar, with a sand/cement ratio of 1/3 E/C= 0.5 at 56 days.
Electron microscopic slide. The Prompt natural cement combines speed of intervention and effective waterproofing over the long term.

Resistance to aggressive waters:

Most of the hydrates formed are very small in size, and highly intertwined. The transition aureoles between the paste and the granulate, which are often highly propitious zones for the transit of damaging solutions, are here fine and of very low porosity, explaining the material's heightened durability.

As it hydrates, the belite will result in only a very low quantity of portlandite (calcium hydroxide). As a result, dissolution through acid attack is very limited, and the formation of secondary gypsum by substitution with sulphates during a sulphate attack is of little significance. Hence a very limited and non-expansive secondary ettringite formation.

Behaviour and presence of sulphated water:
Specimens (2.5x2.5x28 cm) of *Prompt* natural cement mortar (curves 1 and 2) with a sand/cement ratio of ½ and E/C = 0.4 and CEM I 52.5 N PM ES mortar (curves 3 and 4) with a sand/cement ratio of 1/3 and E/C = 0.5 were kept in total immersion (continuous curve) or in a daily drying / wetting cycle (dotted line curves) with 16 hours immersion and 8 hours drying in a magnesium sulphate solution, with a concentration of 50 g/l of water, for one year.

Prompt natural cement mortars and concretes were thus shown to have good resistance to acid water (up to pH 4) and sulphated waters.

Resistance to sea water:

The physical properties (low permeability) and mineralogical characteristics of *Prompt* natural cement concretes and mortars outlined above offer excellent resistance when in contact with sea water.

Performance tests commenced in 1930 at the port of La Rochelle in France (photos). Blocks of natural cement concrete, dosed at 300, 450 and 600 kg/m3 of sand were immersed in the drawdown zone. The 450 and 600kg/m3 concrete blocks were judged to be in fairly good condition by the civil engineering services of La Rochelle in 1986, i.e., 56 years later.

Following these very long term tests *Prompt* natural cement qualified for standard NF P15-314 “cements for sea works”.

This proven resistance to sea water, combined with its waterproofing properties, its quick setting and rapid make it the ideal binder to apply between two tides.

Photos from March 2011

Edition : 07/2012