Natural Cement

NATCEM

PROPERTIES AND TECHNICAL DATA

Description

NATCEM is a cement produced from Natural Alpine stone offering exceptional performance. It contains no additives.

NATCEM is a cement that allows rapid commissioning of civil and structural concrete work.

Natural Cement

NATCEM

Technical Characteristics

Chemical analysis in accordance with NF[1] EN 196-2

MAIN CONSTITUENTS (%)

	L.O.I.	Al_2O_3	CaO	SiO_2	SO_3	Fe_2O_3	MgO
Typical average values	3-6	5-7	48-51	27-30	4-6	3-4	3-4

Particle size distribution

Partical grading (µ)	1	1.5	2	3	4	6	8	12	16	24	32	48	64	96
Minimum (%)	9.15	11.02	14.2	20.3	26.6	34.4	40.2	48.1	54.7	65.4	72.9	80	88.9	100
Maximum (%)	14.12	16.76	21.4	28.1	35.3	44.1	50.8	57.8	64.6	72.7	79.1	89.7	93.6	100

PHYSICAL DATA

Typical average values

Bulk density (cement powder)	: 0.69 - 0.73 g/cm³
True density	: 2.9 g/cm³
Fineness : Blaine specific surface area (to NF[1] EN 196-6)	: 8000 - 10000 cm²/g
Laser particle size analysis - median diameter	: 8 - 12 µ
Laser particle size analysis - fraction larger than 90	: 0%

HYDRAULIC PROPERTIES

Setting time

Mortar complying with NF P 15-401, using the modified mix :
Cement/sand ratio = 1/2
Water/cement ration = 0.40
Sand (complying with AFNOR[2] P 15-403) content = 1350 g
NATCEM cement content = 675 g
Water content = 270 g
Setting in accordance with NF P 15-431 : setting time measured at 20°C using VICAT needle method:

	Start of set	End of set
Typical average values	1'30" - 2'30"	1'00" later

See page 7 : adjusting the set

[1] NF = Norme Française (French Standard)
[2] AFNOR = Association Française de Normalisation (French Standards Institution)

Mortar

CHARACTERISTIC STRENGTHS

In accordance with AFNOR Standard EN 196-1, using a standardised mix :

- Cement/sand ratio = 1/2 (Sand complying with AFNOR Standard) ; Water/cement ratio = 0.40

Time periods	Typical average values in MPa	
	Compressive strength	Flexible strength
15 min	5	1
1 h	7	1.5
3 h	9	2
1 day	16	3
7 days	27	3.5
28 days	51	6
91 days	70	7
6 months	75	8
1 year	83	9

Steady increase in **Compressive strength** over 1 year and thereafter

SHRINKAGE

In accordance with AFNOR Standard EN 196-1, using a standardised mix :

- Cement/sand ratio = 1/2 (Sand complying with AFNOR Standard) ; Water/cement ratio = 0.40. At end of set : demoulding and initial measurements taken.
- Shrinkage 300 - 500 µ measured between end of set and 28 days.

Cast concrete - CEBTP[3] TESTS 3114/6/883

On cast concrete: Cement content : 590 kg/m^3 of concrete placed.
Water/cement ratio = 0.39. Aggregate grading = 0/20 mm.
Setting retarded by addition of citric acid (0.6%) and plasticizer (1%). At 20°C, standard slump = 10.5 cm.

Compressive Strength					
Time periods	3 h	24 h	7 days	28 days	90 days
Typical average values in MPa	12	15	20	39	57

Shrinkage : 323 µ at 28 days

SHOTCRETE

NATCEM cement factor	Ambient temp. °C	Compressive strength of a 10 x 10 cm cube (average strength of 3 cubes in MPa)					
		3 h	5 h	24 h	7 days	28 days	90 days
350 kg/m^3	25	9.5	n.m.*	21	n.m.*	39	n.m.*
450 kg/m^3	13	15.8	18.3	31	33.7	56.3	57.5

*n.m. : not measured

HEAT OF HYDRATION

Measured using a Langavant calorimeter in accordance with NF P15-436, modified as per NF P15-314, the heat of hydration lies in the range : 70 - 150 J/g after 1 hr, or 17 - 36 cal/g after 1 hr.

SUITABILITY FOR FOOD INDUSTRY APPLICATIONS

NATCEM may be used in food industry facilities; it is fully endorsed by CREPEC[4] Ville de Paris Approval 92 MAT 036 of 04/05/93.

Result of relevant analyses :

- Quick screening test : Satisfactory
- Test for cytotoxicity : Satisfactory
- Analytical fine screening test : Satisfactory

[3] CEBTP = Centre d'Etudes pour le Batiment et let Travaux Publics (French Building Research Centre)
[4] CRECEP = Centre de Recherche et de Controle des Eaux de Paris (Paris Water Research and Testing Unit)

Natural Cement

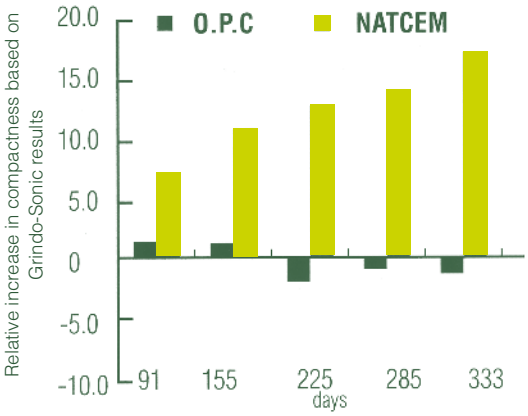
NATCEM

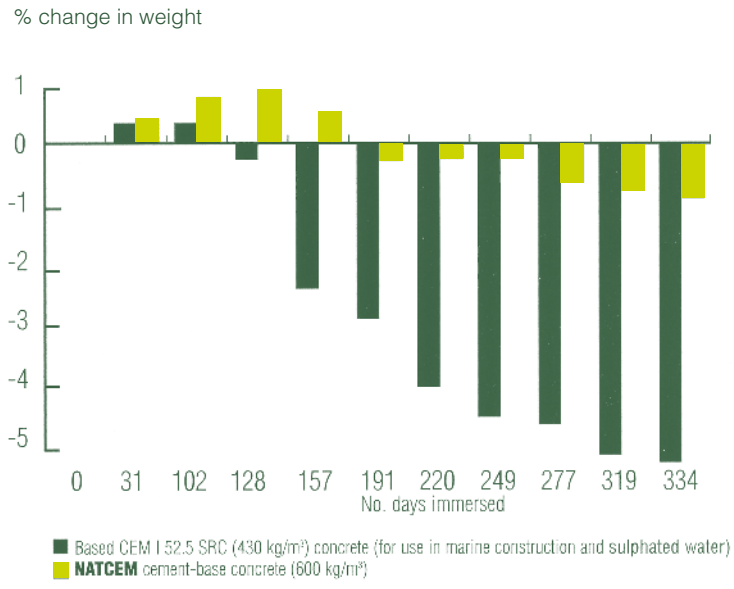
Technical Characteristics (cont.)

Chemical attack

Histograms of resistance to sulphuric acid (pH = 4)

Comparison of compactness development for a **NATCEM** cement-based concrete in the presence of sulphuric acid





Resistance to seawater and sulphated water

In accordance with NF P 18 837 Standard (special products intended for hydraulic binder based concrete work) *(C.E.B.T.P. Test No. 3114.6.883)*

Mix designation	Age	Expansion in µ		
		Fresh water	Seawater	Sulphated water
NATCEM + 0.3% citric acid, 1/2 mortar, w/c = 0.40	7 days	13	17	13
	28 days	13	37	30
	3 months	40	120	70
	6 months	40	133	70
O.P.C. CEM 1 52.5 1/3 mortar, w/c = 0.33	7 days	17	73	23
	28 days	23	227	83
	3 months	97	1147	235
	6 months	97	2047	360

According to the **NF P 18 821** Standard covering standard guaranteed properties for special products intended for hydraulic binder-based concrete work : “After six months immersed in fresh water, the elongation of test specimens shall be **less than or equal to 400 µ**. After six months immersed in either seawater or sulphated water, the elongation of test specimens shall be **less than or equal to 600 µ**.”

Bonding of NATCEM cement-based concretes to steel reinforcement

(C.E.B.T.P. Test No. 3114.6.883 in accordance with RILEM[5] recommendation RC6)
Test using 20 mm dia. high tensile deformed bar (Fe500) :

	Max. tensile 28-day comp.		Bond strength (MPa)	Reference bond strength (MPa)*
	force (kN)	strength (MPa)		
Cast concrete with a 600 kg/m³ **NATCEM** cement factor	120.2	38.8	19.1	14.8
Cast reference concrete with a 400 kg/m³ O.P.C. CEM **I** 52.5 cement factor	117.7	46.6	18.7	12.0

* The reference bond strength is corrected to correspond with a 30 MPa compressive strength.
[5] RILEM = Reunion Internationale des Laboratoires d'Essais de Recherche sur les Materiaux de Construction, octobre 1973. (International Meeting of Construction Materials Research Laboratories, October 1973).

Carbon Dioxide Penetration - C.E.B.T.P. Test

The principle underlying the accelerated carbon dioxide penetration test is to measure the depth of carbonation on a failure surface. 4 x 4 x 16 cm prismatic mortar specimens were used. After storage for 28 days in a damp room (20°C - 99% R.H.), the mortar specimens were placed in a container enclosing a controlled atmosphere comprising 70% CO_2 at 20°C and 50% R.H. After 1-3-710-21-28-36 and 60 days, the specimens were broken under shear and measurements of carbonation were taken by spraying a water-alcohol solution of phenolphtaline onto the failure surface. The depth of carbonation is the average of the carbonated depths measured on all four sides of the specimen.

The depth of carbonation for a **NATCEM** cement-based mortar (1/2) and a reference CEM **II** b 32.5 cement-based mortar (1/3) are given in the following table:

Age (days)	Depth of carbonation (mm)	
	CEM **II** b 32.5 ref. mortar	NATCEM mortar
1 day	1	0
3 days	2	0
7 days	3	1
10 days	3.5	1
21 days	3.5	1
28 days	5	1.5
36 days	8	1.5
60 days	14	1.5

The rate of carbonation for the NATCEM cement-based mortar is thus very low and the carbonation appears to cease after 1 month.

Bonding ("Pull Out")

TESTED IN ACCORDANCE WITH NF P 18 821 STANDARDS : PULL OUT TESTS FOR HYDRAULIC BINDER-BASED FIXING GROUTS. 7-day results for a vertical rod grouted in a block :

NATCEM : (sand/cement = 1/1, w/c = 0.33)	Deflection * of grouted rod under a 45kN load w.r.t. concrete support	Load at failure (kN)
on a dry support	0.3	49.4
on a damp support	0.24	50.1

[1] *Deflection of the rod with respect to the surrounding concrete must be less than 0.5 mm to comply with the Standard*

Natural Cement

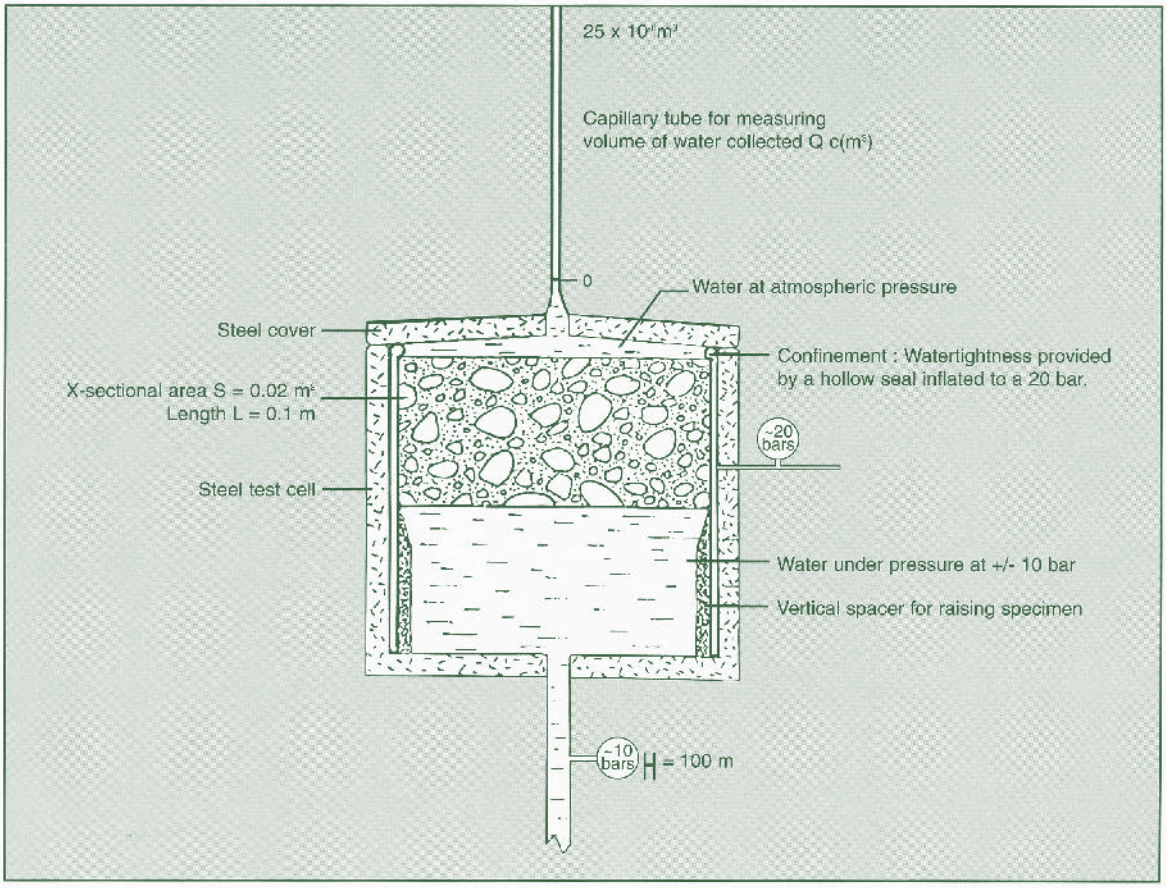
PERMEABILITY OF NATCEM CEMENT-BASED CONCRETES TO WATER

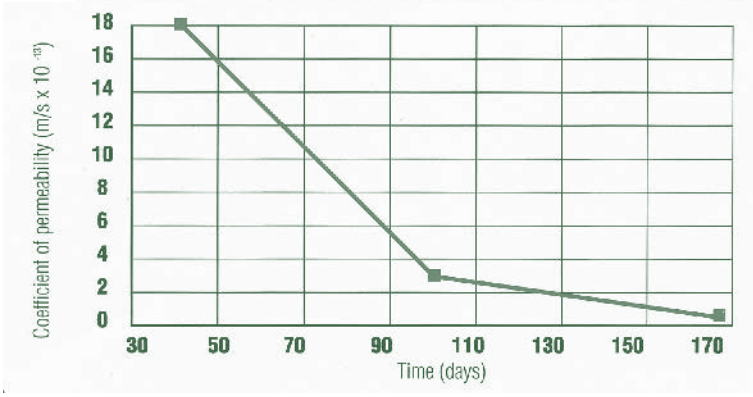
"SIGMA" Concrete test

The test specimen is obtained cutting a 10 cm long section from a 16 cm dia. x 32 cm long concrete test cylinder with a 600 kg/m³ **NATCEM** cement content. The specimen is then placed in a PERRIER permeameter (shown in the diagram hereunder).

Permeability test results may be expressed using the following formulae :

Coefficient of permeability K (m/s) = QL / HST, with T in seconds.





At 40 days, the coefficient of permeability of **NATCEM** cement-based concrete is close to that of a conventional concrete, which remains constant with time. However, when **NATCEM** is incorporated in the mix, the coefficient of permeability decreases rapidly with time and after several months, the concrete has a low permeability.

ADJUSTING THE SET

NATCEM's natural setting time is very short (2 min.). There are several ways to adjust and control the setting time for different applications.

Adding Anhydrous Citric Acid (E 330)

Influence of E 330, Temperature and Dosage

For a mortar with a cement/sand ratio = 1/2 and w/c - 0.37
Start of set / end of set shown in following table :

Ambient temperature / Citric Acid	0%	0.2%	0.4%	0.6%	0.8%
5°C				49' / 55'	
10°C				23' / 25'	
20°C	2' / 2'30	7' / 7'30	12'30 / 13'30	19' / 20'30	27'50 / 29'20
25°C				14'30 / 15'	
30°C				11' / 12'	

Values shown are indicative only.

Influence of Water : Cement Ratio on Setting Time

Tests carried out at 20°C

For a mortar with a cement/sand ratio = 1/2 and 0.6% citric acid mixture.

w/c	0.34	0.37	0.4	0.5
Start of set / end of set	13' / 17'	19' / 20'30"	30' / 34'	35' / 40'
Consistency	firm	mastic	plastic	fluid

NATCEM is compatible with Portland cements.

Consult us for designs of NATCEM / PORTLAND mixes.

Manufacturer & Technical Support

10-11 Fountain Parade, Mapplewell, Barnsley, South Yorkshire S75 6FW
e. enquiries@naturalcement.co.uk **t.** 01226 381133 **f.** 01226 381177
www.**naturalcement**.co.uk