



**NATCEM** IS A CEMENT THAT  
ALLOWS RAPID COMMISSIONING OF  
CIVIL AND STRUCTURAL CONCRETE  
WORK

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

# PROPERTIES AND TECHNICAL DATA

# TECHNICAL CHARACTERISTICS

## CHEMICAL ANALYSIS IN ACCORDANCE WITH NF<sup>1</sup> EN 196-2

MAIN CONSTITUENTS (%)

	L.O.I.	Al <sub>2</sub> O <sub>3</sub>	CaO	SiO <sub>2</sub>	SO <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	MgO
Typical average values	3-6	5-7	48-51	27-30	4-6	3-4	3-4

## PARTICLE SIZE DISTRIBUTION

Particle 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/cm <sup>3</sup>
True density	: 2.9 g/cm <sup>3</sup>
Fineness : Blaine specific surface area (to NF <sup>1</sup> EN 196-6)	: 8000 - 10000 cm <sup>2</sup> /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 following modified mix :  
Cement/sand ratio = 1/2  
Water/cement ration = 0.40  
Sand (complying with AFNOR<sup>2</sup> 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**

<sup>1</sup> NF = Norme Française (French Standard).

<sup>2</sup> AFNOR = Association Française de Normalisation (French Standards Institution).

# TECHNICAL CHARACTERISTICS (contd.)

## 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 - 550  $\mu$  measured between end of set and 28 days.

## CAST CONCRETE - CEBTP<sup>3</sup> TESTS 3114/6/883

On cast concrete: Cement content : 590 kg/m<sup>3</sup> 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.

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

**SHRINKAGE : 323  $\mu$  at 28 days**

## SHOTCRETE

NATCEM cement factor	Ambient temp. °C	Compressive strength of a 10 x 10cm cube (average strength of 3 cubes in MPa)					
		3 h	5 h	24 h	7 days	28 days	60 days
350 kg/m <sup>3</sup>	25	9.5	n.m.*	21	n.m.*	39	n.m.*
450 kg/m <sup>3</sup>	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 CRECEP<sup>4</sup> 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

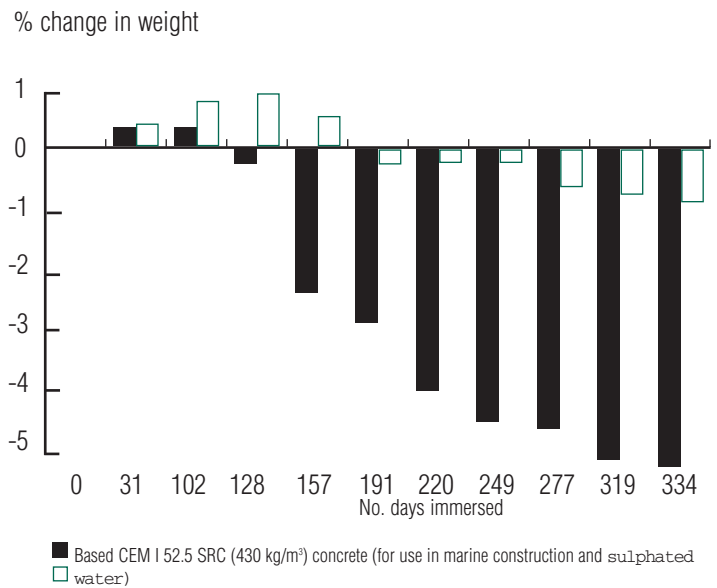
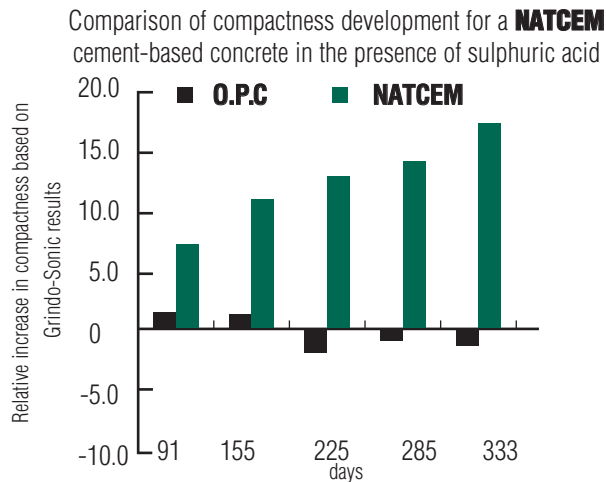
<sup>3</sup> CEBTP = Centre d'Etudes pour le Batiment et les Travaux Publics (French Building Research Centre).

<sup>4</sup> CRECEP = Centre de Recherche et de Contrôle des Eaux de Paris (Paris Water Research and Testing Unit).

# TECHNICAL CHARACTERISTICS (contd.)

## CHEMICAL ATTACK

### HISTOGRAMS OF RESISTANCE TO SULPHURIC ACID (pH = 4)



## 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 $\mu$		
		Fresh water	Seawater	Sulphated water
<b>NATCEM</b> + 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  $\mu$** . After six months immersed in either seawater or sulphated water, the elongation of test specimens shall be **less than or equal to 600  $\mu$** ."

## BONDING OF NATCEM CEMENT-BASED CONCRETES TO STEEL REINFORCEMENT

(C.E.B.T.P. Test No. 3114.6.883 in accordance with the RILEM<sup>5</sup> recommendation RC 6)

Test using 20 mm dia. high tensile deformed bar (Fe500) :

	Max. tensile force (kN)	28-day comp. strength (MPa)	Bond strength (MPa)	Reference bond strength (MPa)*
Cast concrete with a 600 kg/m <sup>3</sup> <b>NATCEM</b> cement factor	120.2	38.8	19.1	14.8
Cast reference concrete with a 400 Kg/m <sup>3</sup> 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.

<sup>5</sup> RILEM = Reunion Internationale des Laboratoires d'Essais de Recherche sur les Matériaux de Construction, octobre 1973. (International Meeting of Construction Materials Research Laboratories, October 1973).

# TECHNICAL CHARACTERISTICS (contd.)

## 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<sub>2</sub> at 20°C and 50 % R.H. After 1-3-7-10-21-28-36 and 60 days, the specimens were broken under shear and measurements of carbonation were taken by spraying a water-alcohol solution of phenol phtalene 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 :

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

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

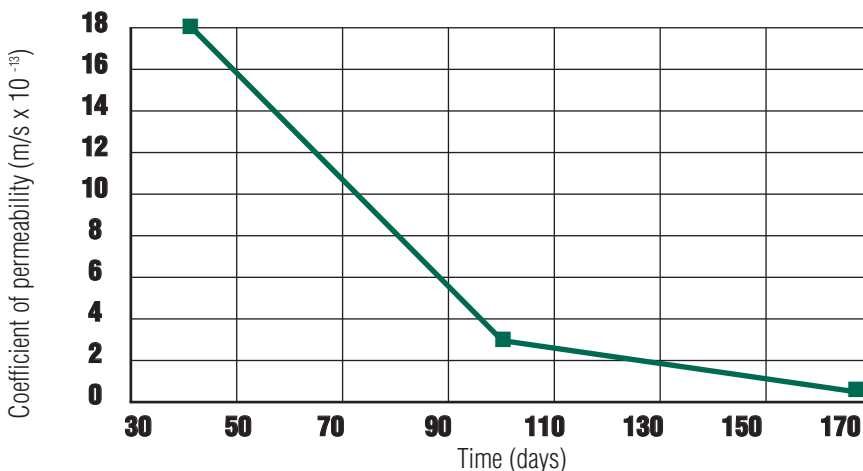
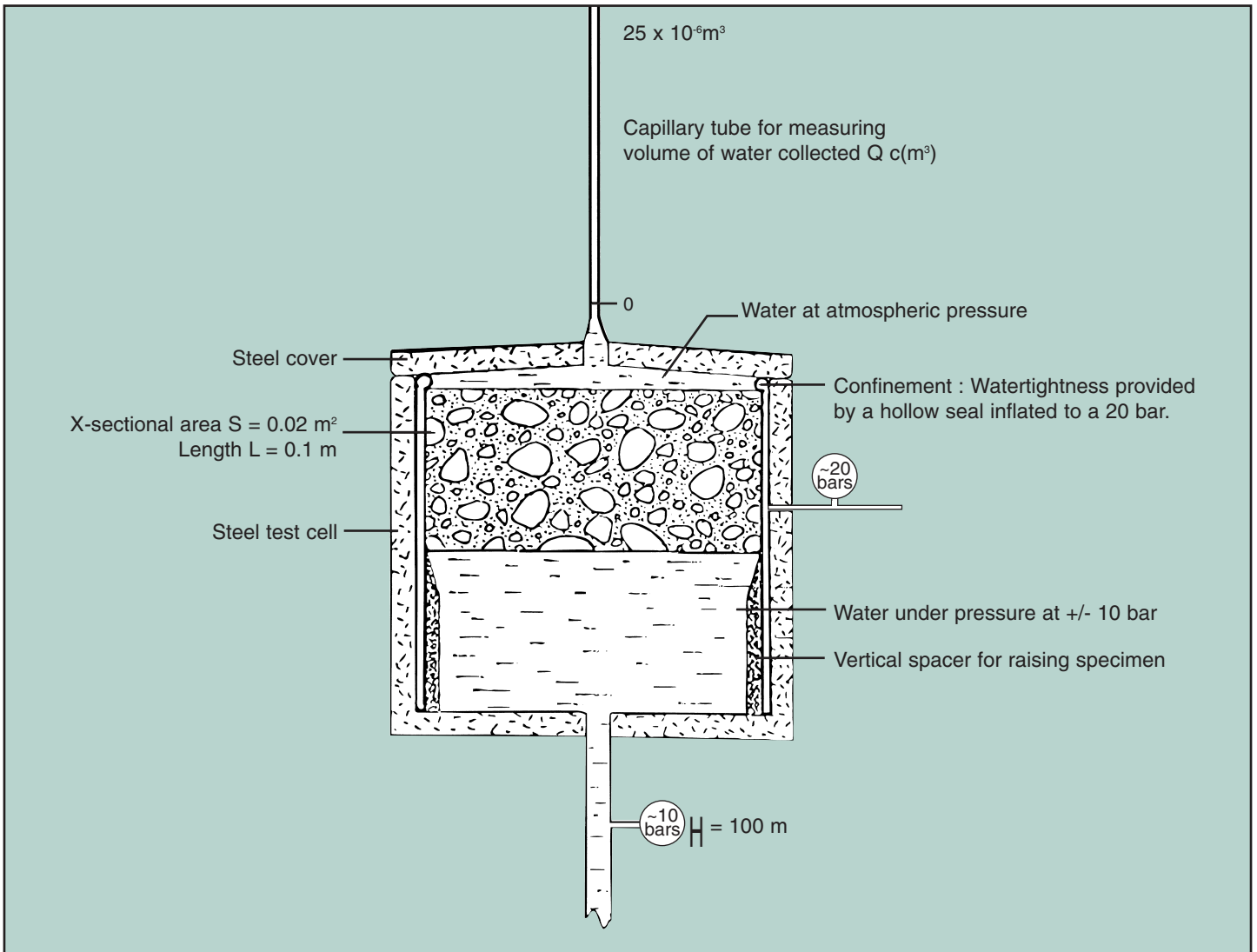
# PERMEABILITY OF NATCEM CEMENT-BASED CONCRETES TO WATER

## “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/m<sup>3</sup> **NATCEM** cement content. This specimen is then placed in a PERRIER permeameter (shown in the diagram hereunder).

Permeability test results may be expressed using the following formule :

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 admixture

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.***

