Dr. Ferran Gomà i Ginestà
Professor de Patologia i Control de l´Edificació
E.T.S.A.B. UNIVERSITAT POLITECNICA DE CATALUNYA
Travessera de Gràcia, 266 s/at. 1ª
Tel : 845 26 68 i Fax
08025 - B A R C E L O N A

D.N.I. = 36.188.550. - M.

CEMENTOS COLLET S.L.
Cementos Naturales.
Colònia Collet d'Eyne
08694 GUARDIOLA DE BERGUEDÀ
N.I.F. B-08056996

Reference Collet 7 in Control FC.102

1. – INTRODUCTION

We received, , a series of samples of Marfil-Pur cement from Cementos Collet, corresponding to the production from the second quarter of the present year, 2007, to evaluate its quality in relation to the existing norms,

We took a representative simple from the selection available according to the specification of the existing Norm, and carried out the physical and chemical analysis established in the new regulations.

At present, the Norm which corresponds to natural cement is **UNE EN 80.309-May 2006 [1]** and it refers to the definition, classification and specifications of Natural cement or masonry cement.

The Norm **UNE EN 413 – 1st of February 2005, [2], regulates the composition, specifications and criteria for conformity of masonry cements.**
a Norma **UNE EN 413 – 2nd of May 2006, [3], regulates the procedures for testing masonry cements.**

The Norm **UNE EN 80309 defines that the composition of natural cements is obtained by calcination of natural marls at a sufficiently high temperature, but below that of its clinkerisation temperature.**

These marls have a variable composition according to the different geological strata from which they are composed. The variations in composition are defined by the majority oxide content and are wide ranging within the established limits.

The cement MARFIL – PUR from Cementos Collet, has a specific characteristic given that it comes from one single geological strata of constant composition and the raw material consists of this single stratum only. Therefore, it is produced exclusively by mining, with no mixing, and as such its composition is exceptionally consistent.

This is the only cement in the country that is obtained by subterranean mining of a known geological stratum of consistent composition.

Consequently, its properties completely comply with the aforementioned Norms and the quality of the cement is highly superior to ordinary cements of this class.

This condition of the natural substance of the raw material gives a guarantee of quality that no other type of natural cement can offer.

For this reason, the consistency of its physical and chemical parameters and its exceptional properties of resistance to attack by sulphates **[4]**, we consider this cement to be special, and distinct from any other type of cement existing within the category specified by the Norms dealing with this type of cement.

2.- RESULTS OF THE EXPERIMENT

2.1.- Physical parameters

It has been determined that the physical characteristics are in accordance with the recent Norm UNE **EN 413-2, Mayo 2006** in which the conditions of testing for natural (or masonry) cements are specified.

2.2.- Normal Consistency

In accordance with the manufacturer's instructions, the use of this cement has evolved. Initially used mixed with sand, the cement is now applied directly without the addition of sand in the majority of masonry applications. In this way a faster working method and much higher resistance are achieved, and the cement easily exceeds the resistance requirements.

We have determined that the optimal water content for use, adjusting its value to normal consistency specified in the corresponding Norm **413-2/2006**.The results are shown in the following Table no.1

TABLE 1

Sample reference	Water content in %	Penetration of probe	Normal Consistency NORM **EN 413-2/2006**
Sample 1	**0.41**	**37**	**Penetration of probe 35 mm.**
Sample 2	**0.39**	**34**	**35 mm.**

2.3. - Relation Water / Cement

The relation of water to cement that corresponds to the normal consistency according to the Norm is **0.40** and this consistency is recommended in the manufacturers instructions for application both with and without the addition of sand.

2.4. - Setting Times

We have determined the setting times for normal consistency according to the Norm **196 - 3** and the values are shown below.

TABLE 2

Sample Reference	Initial Setting Minutes	Final Setting Minutes	Normal Consistency **EN 196 - 3** Penetration of the probe
Sample 1	**2' 10''**	**4' 10''**	35 mm.
Sample 2	**2' 40''**	**4' 50''**	35 mm.
According to Norm **UNE 80.309 - 2006**			35 mm.

CNR 4 CNR 8	> 1 > 1	< 8 < 8	

The setting times at this recommended normal consistency comply with the existing Norms.

2.5. – Modification of the setting times with the addition of citric acid.

If a longer time is required this can be achieved with the addition of a small amount of citric acid. The proportion indicated in function of the setting time required has been determined in the laboratory using the cement samples supplied by the factory.

From these results, shown below, the amount of retardant required for each setting time required.

TABLE 3

Weight of cement, in g	mL distilled water	Weight of citric acid, in g	% citric acid / weight of cement	Relation a/c	Setting time in minutes	Ref.
300	**120**	**0.3030**	**0.10**	**0.4**	**4.5**	**1**
300	**120**	**1.0116**	**0.34**	**0.4**	**13**	**2**
300	**120**	**1.3036**	**0.43**	**0.4**	**16**	**3**
300	**120**	**1.6087**	**0.54**	**0.4**	**22**	**4**

2.6. – Resistance to compression

We have determined the resistance to compression through a series of tests according to the Norm **UNE 196 – 1** and the standard statistical constants. The cement was used without the addition of sand

The results are expressed in the following table

TABLE 4

Resistance to Compression **N/mm^2**	SAMPLE Relation **Water/cement 0.40**	SAMPLE Relation **Water/cement 0.33**	**MÍNIMUM VALUES UNE 80.309 2006** **CNR 4**	**CNR 8**
1 Hour	**2.0**	**8.2**	0.5	1.0
3 “	**4.3**	**12.7**	0.8	1.5
6 “	**7,0**	**18.0**	1.0	2.0
24 “	**10.3**	**24.5**	1.2	2.5
7 Days	**11.1**	**26.5**	2.0	5.2
28 “	**12.2**	**27.8**	4.0	8.0

TABLE 5

Resistance to compression at 28 days according to **EN 196 - 1**

Relation Water/cement 0.40	**Maximum tension kN**	**R_{28} N/mm^2**
1	**16.320**	**10.2**
2	**18.880**	**11.8**
3	**19.680**	**12.3**
4	**20.000**	**12.5**
5	**20.800**	**13.0**
6	**21.120**	**13.2**

R 28	$\bar{X}_{R28}$	**12.2**
	σ	**0.99**
	C.V. %	**8.12**

Resistance to compression at 28 days according to **EN 196 - 1**

TABLE 6

Relation Water/cement 0.33	**Maximum tension kN**	R_{28} **N/mm²**
1	**41.600**	**26.0**
2	**42.880**	**26.8**
3	**43.840**	**27.4**
4	**45.600**	**28.5**
5	**46.400**	**29.0**
6	**46.720**	**29.2**

R 28	$\bar{X}_{R28}$	**27.8**
	σ	**1.17**
	C.V. %	**4.22**

2.7.- Particle size

We have determined the particle size according to the Norm **UNE 80 309**

The results referring to the composition of particle size are shown in the following table.

TABLE 7

Fineness of ground cement % Reject on sieve	**Marfil - Pur Collet**	**UNE 80.309 / 2006**
160 µm	**19 % %**	< 17 %

80 μm	**39 %**	< 35 %

These values are slightly higher than those stipulated because the practical use of natural cement in recent years has evolved in the sense that users prefer the performance of directly applied cement, practically without the addition of sand.

The average sample of our quarterly control is very close to the Norms.

2.8.- Chemical parameters

A chemical analysis was carried out in accordance with the existing Norm **UNE-EN 196-2**. The values are expressed in the following table.

TABLE 8

Results expressed in %	Average sample (Alkaline Separation)	According to **UNE 80.309 - 2006 EN 196 - 2** Values in %
T_iO_2	**0.24**	
S_iO_2	**22.0**	> 18
Al_2O_3	**8.9**	> 5
Fe_2O_3	**3.0**	> 2
CaO	**46.7**	

		> 45
MgO	**2.4**	Not considered
SO_3	**3.0**	< 4.0
K_2O	**1.7**	Not considered
Na_2O	**0.27**	Not considered
P.F. 550º C P.F. 550 a 950ºC	**1.1** **10.2**	Total loss < 16
free **Cal**	**0.80**	Not considered
Insoluble residue	**9.2**	< 10
Soluble fraction	**90.8**	
Alkalis expressed in Na equivalent	**1.4**	Not considered

3.0.- CONCLUSION

The cement studied complies with the existing Norms in the fundamental points, such as **CNR 4** and **CNR 8,** utilised in accordance with the manufacturer's recommended technique of using the cement without sand.

Its resistance is very high and therefore allows work to be carried out quickly with excellent operative results.

Complementary studies on its durability show that the formation of secondary Ettringite is not expansive which confers a very high resistance to sulphate attack.

The durability of this natural cement is excellent with respect to the presence of sulphate and the tests with standard cubic specimens have shown a special total resistance to attack by sulphates after 7 years of immersion in seawater or after saturation with calcium sulphate (plaster) **[5].**

Its principle applications are those undertaken en seawater and/or land below the sea level. It is also a cement that can be used in terrain rich in calcium sulphate such as the *Monegros*.

Signed Prof. Dr. F. Gomà

Laboratori de Recerca Química
30-10-07

(Chemical Research Laboratory)

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