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Analyse Service GmbH

RFA Ringversuch ATILH, Frankreich - PZ CEM I 52,5 N

Veranstalter des Ringversuchs: Association Technique de l'industrie des liantshydrauliques (ATILH)
Ringversuchsmaterial: Portlandzement CEM I 52,5 N
RV geschlossen: 2021 - 3
Literatur: Bericht Ringversuch (Laborcode 139)

Hauptelemente [MA%]

	CRB	RV	1sRV	Z-Score
SiO_2	21,060	21,290	0,210	-1,100
Al_2O_3	3,410	3,490	0,140	-0,570
Fe_2O_3	4,880	4,890	0,120	-0,080
TiO_2	0,140	0,140	0,010	0,000
P_2O5	0,260	0,260	0,010	0,000
SO_3	2,550	2,310	0,090	2,670
CaO	64,300	64,390	0,440	-0,200
MgO	1,280	1,280	0,090	0,000
K_2O	0,500	0,500	0,030	0,000
Na_2O	0,210	0,210	0,030	0,000
SrO	0,092	0,090	0,010	0,200
MnO	0,130	0,140	0,020	-0,500
LOI	1,020	0,930	0,120	0,750

Legende

CRB: Ergebnisse CRB – **RV:** Ergebnisse Ringversuch -- **1s-RV:** Standardabweichung Ringversuch
Z-Score: Differenz des Messwertes vom Mittelwert des Ringversuchs -- ***** Wert nicht zertifiziert

ATILH
ASSOCIATION TECHNIQUE DE
L'INDUSTRIE DES LIANTS HYDRAULIQUES

Interlaboratory testing Programme

2020

Final report

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SUMMARY

Interlaboratory Testing Programme 2020

1. INTRODUCTION

The conditions linked to the pandemic forced us to restrict participation only to laboratories in the Europe zone.

There were **134** laboratories participating this year, of which:

15 European pilot laboratories,

60 Laboratories of the French cement industry and French organizations using cement,

59 European laboratories.

A total of 21 **countries** took part in this program:

- **ALBANIA**
- **AUSTRIA**
- **BELGIUM**
- **DENMARK**
- **FINLAND**
- **FRANCE**
- **GERMANY**
- **GREECE**
- **IRELAND**
- **ITALY**
- **LITHUANIA**
- **LUXEMBOURG**
- **THE NETHERLANDS**
- **POLAND**
- **PORTUGAL**
- **ROMANIA**
- **SLOVAKIA**
- **SPAIN**
- **SWEDEN**
- **SWITZERLAND**
- **THE CZECH REPUBLIC**

The cement used in this testing programme was a **CEM I 52,5 N** complying with the European Standard NF EN 197-1.

2. GENERAL CONSIDERATIONS

2.1 Organization.

Five tons of CEM I 52,5 N (as per European standard NF EN 197-1:2012) were homogenized so as to obtain as identical samples as possible, then conditioned in metallic waterproof recipients.

Data submitted by the participants are presented in tables at the end of this report, in the same order as that of the questionnaire. Results are presented identically for each analysis: first a determination of the mean for all methods used put together, then a comparative analysis for each participant, for all methods used, then per method. A mean is also determined for the less popular test methods (< 12 values).

There are three groups of results to be taken into consideration, those of the European pilot laboratories, the French factories and user laboratories and finally the European laboratories.

The French cement manufacturers' Central Laboratories, the Materials Laboratory of the City of Paris and European most experience laboratories compose the pilot laboratory group.

2.2 Objectives.

Many types of tests are used, involving one or more laboratories, one or more operators, and implementing different experimental programmes where the test results are submitted to statistical analyses. This is due to the variety of purposes they were designed for: self-regulation, process management, acceptance inspection, round-robin tests, …

ATILH's round-robin tests aim at a better knowledge of cement, of its technology and of what can be expected of it. Our test programmes allow each participant to estimate the position of their results within the same test class. They will also contribute to improvements in resource management, help evaluate the operators' qualifications and check on the quality of the equipment and the validity of the operating procedures. Finally, these tests are part of quality control monitoring.

2.3 Statistical analysis of the results.

A few definitions in statistics:

- Precision: closeness of the experimental values obtained throughout a set of experiments done under given conditions.

- Repeatability: precision in the case of a single operator in a given laboratory obtaining repeated results testing an identical product with the same material and the same method.

- Reproducibility: precision in the case of several operators in different laboratories or in the same laboratory but working at different times, each obtaining individual results testing an identical product with the same method.

2.3.1 General data

The most common approach, supported by the Gauss distribution convergence theorem, is that most distributions found in physic-chemical measures or in industrial practice is noticeably Gaussian.

"Normal" or Laplace-Gauss distribution (***NF X 06-050***) consists solely of two parameters: means m and standard deviation S, respectively $\bar{x}$ and s_R in the statistical tables of this report.

For this type of distribution, we show that :

68 % of the results are between (m - σ) and (m + σ)

95 % of the results are between (m - 2σ) and (m + 2σ)

99,7 % of the results are between (m - 3σ) and (m + 3σ)

For these round-robin tests, P is the probability of the observed value in the test, where, if:

P $\geq$ 5 %, then the recorded value is considered as correct

2 % < P < 5%, then the recorded value is considered as suspect

P < 2 %, then the recorded value is considered as an outlier

2.3.2 Statistical analysis proper

Every laboratory having given a result for each method used; we are here in the case of reproducibility. Our analysis follows the usual three steps:

a) Elimination of outlier values done on a 98% level through Student's test, minimum and maximum values being determined through the expression:

$$\textbf{Lm et LM} = x \pm s.t_{n-1}$$

Where t_{n-1} is the number of standard deviation separating the mean from the limit, a given value from the STUDENT distribution table, for level ***of significance value*** set at 0,02 and the degree of freedom N = n-1)

b) A reiteration is applied to this level so as to retain only the values attached to the distribution. "Outlier" values are eliminated from the final computations.

c) A classical **reduction of the data**. The various parameters and characteristic that can be computed are divided into two categories:

. ***CENTRAL TREND* PARAMETERS**

The arithmetic mean x: where $\mathbf{x_i}$ is the observed value and **n** the total population ***(in the sample)***

$$\bar{x} = \frac{\sum_{i=1}^{n} \bar{x}_i}{n}$$

DISPERSION PARAMETERS

Experimental variance $\mathbf{S^2}$ estimated from the sample of population **n**, determined by:

$$S^2 = \frac{\sum_{i=1}^{n} (x_i - x)^2}{n-1}$$

Experimental standard deviation **S**, estimated from the square root of the variance

$$S = \sqrt{\frac{\sum_{i=1}^{n} (x_i - x)^2}{n-1}}$$

Coefficient of variation **V**, used for comparing dispersions:

$$V(\%) = \frac{s \times 100}{|x|}$$

Interpretation of the data:

The "empirical" characteristics above are to be clearly differentiated from the theoretical ones of the "model" to which we will try to link the recorded observations. We have assumed that the "population" that has been studied ***will bear the comparison*** to a statistical law or theoretical model.

The ***level of critical value***, i.e. the degree of probability or degree of confidence targeted is set at 0,05**,** which means a 95% chance that interpretation of results will conform to the hypothesis.

Values outside the range determined by level 95 are considered as suspect but are computed statistically.

The precision of the measure or the maximum probable error to be expected can be determined by the following expression, placed after the mean in the statistical tables, in $\pm \varepsilon$:

Where t_{n-1} is a value from the STUDENT table at the selected ***level*** of confidence:

$$\varepsilon = \frac{s}{\sqrt{n}} \cdot t_{n-1}$$

SYMBOLS OF METHODS

CHEMICAL DETERMINATIONS

	Loss on ignition	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Alklies	SO_3	Free lime	Insoluble residue	Cl	TiO_2	P_2O_5	SrO
A	*θ = 1000°c T=20min*	*Atomic Absorption (AAS)*										*Atomic Absorption (AAS)*		
B	*θ < 1000°c T=20min*	*Quinoléine*							*Glycerin Alcohol*					
C	*θ = 1000°c T<20min*	*CH_2-CH_2-O*	*Complexometry*						*Glycol Complexometry*					
D	*θ < 1000°c T>20min*	*Double Insolubilite*												
E	*θ < 1000°c T=20min*	*NH_4Cl*						*Eltra*	*Ethylene Glycol*					
G	*θ = 1000°c T=15min*	*Gelatin*						*Gravimetry*	*Glycol Acidimetry*					
K*	*θ = 950°c T=15min*	*Double Insolubilite*	*Complexometry*				*Flame photometry*	*Gravimetry*		*Gravimetry*	*$AgNO_3$*			
L	*θ = 1000°c T>20min*							*Leco*	*Glycol Conductimetry*					
M		*Plasma (ICP)*										*Plasma (ICP)*		
P	*θ < 1000°c T=20min*	*$HClO_4$*					*Flame photometry*				*Potentiometry*			
T	*Thermo gravimetry*							*Turbidimetry*	*Thermo gravimetry*					
X	*θ < 1000°c T<20min*	*X-ray fluorescence*									*X-ray fluorescence*			

*** CEN reference method**

PHYSICAL DETERMINATIONS

	Specific gravity	Granulometer	Setting time test	Mechanical tests
A	ASTM – NBS standard	Alpine sieving	Automatic apparatus	AFNOR Sand, CEN Standard
B		Other sieving		AFNOR Sand, National Standard
C				National Sand, National Standard
D				National Sand, CEN Standard
G	Atilh standard			
L	Lafarge standard	Laser granulometer		
M			Manual test	

N : ***For the individual case (Physical, Chemical or Mechanical tests) not mentioned method or few results.***

UNITS OF MEASURE

Chemical, Granulometry Mineralogy and normal consistency	Specific gravity	Specific surface	Setting time	Soundness	Skrinkage and Swelling	Heat of hydration	Maximum heat and Age maximum	Maniability fluidity	Mass on demoulding	Compression and Bending strengths
%	g/cm^3	cm^2/g	min	mm	µm/m	J/g	J/g/h and h	s	g	MPa

CEMENT STANDARDS

NF EN 197-1	*Cement*	*Composition, specifications and conformity criteria for common cements*
NF EN 196-1	*Methods of testing cement*	*Determination of strength*
NF EN 196-2	*Methods of testing cement*	*Chemical analysis of cement*
NF EN 196-3	*Methods of testing cement*	*Determination of setting time and soundness*
CEN TR/ 196-4	*Methods of testing cement*	*Quantitative determination of constituents*
NF EN 196-5	*Methods of testing cement*	*Pozzolanicity test for pozzolanic cement*
NF EN 196-6	*Methods of testing cement*	*Determination of fineness*
NF EN 196-7	*Methods of testing cement*	*Methods of taking and preparing samples of cement*
NF P 15-433	*Methods of testing cement*	*Determination of shrinkage and swelling*
NF EN 196-8	*Methods of testing cement*	*Part 8: heat of hydration - solution method*
NF EN 196-9	*Methods of testing cement*	*Part 9: heat of hydration - semi-adiabatic method*
NF EN 196-10	*Methods of testing cement*	*Part 10: Determination of the water-soluble chromium (VI) content of cement*
NF EN 196-11	*Methods of testing cement*	*Part 11 : heat of hydration – Isothermal conduction calorimetry method*
XP P 15-437	*Testing technics*	*Characterization of cements by fluidity measurement under mortar vibration*
NF P 18-452	*Concrete*	*Measuring the flow time of concretes and mortars using a workabilitymeter*
NF X 06-050	*Statistical*	*Statistical application – Study of the normal distribution*

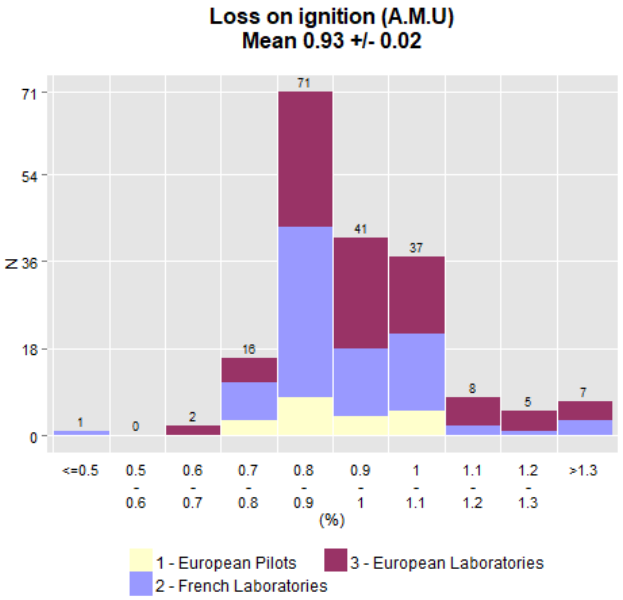
SYMBOLS BY STATISTICS

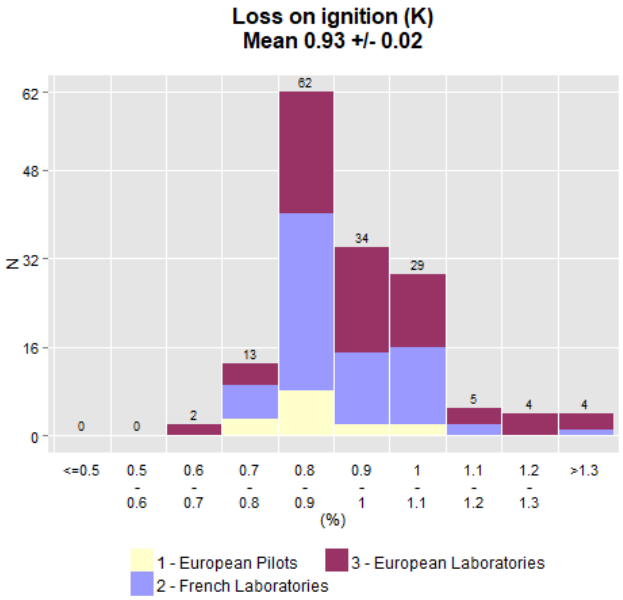
A.M.U.	*All methods used*
Nb	*Number of test per laboratory* or number of laboratory
$\bar{x}$	*Arithmetic mean*
ε	*Precision of a measure of the mean (5%)*
S_R	*Standard of deviation of reproductibility*
CV	*Coefficient of variation (V%=S/x)*
Lm 95%	*Lower confidence limits after elimination of outliers*
LM 95%	*Upper confidence limits after elimination of outliers*

3. Table results of the test campaign 2020 - All people and all methods used

	Nb Labo	Nb Results	Mean (%)	S_R (%)	*CV* (%)	Lm95%	LM95%
Loss on ignition	121	180	0.93	0.12	12.5	0.70	1.16
SiO2	110	164	21.29	0.21	1.0	20.87	21.70
Al2O3	114	171	3.49	0.14	4.0	3.21	3.76
Fe2O3	113	172	4.89	0.12	2.5	4.65	5.13
CaO	112	170	64.39	0.44	0.7	63.52	65.25
MgO	111	168	1.28	0.09	6.7	1.11	1.45
MnO	70	94	0.14	0.02	14.4	0.10	0.17
SO3	123	242	2.31	0.09	3.8	2.14	2.48
Free lime	97	119	1.19	0.19	15.6	0.82	1.55
Insoluble residue	104	144	0.33	0.14	43.2	0.05	0.61
Na2O	113	167	0.21	0.03	16.7	0.14	0.28
K2O	112	163	0.50	0.03	6.0	0.44	0.56
TiO2	92	124	0.14	0.01	9.3	0.11	0.16
Chloride	111	149	0.008	0.005	70.2	-0.003	0.019
P2O5	92	128	0.27	0.01	5.5	0.24	0.30
SrO	61	83	0.09	0.01	7.7	0.07	0.10
CO_2	39	39	0.42	0.12	28.0	0.18	0.66
S^{--}	45	45	0.011	0.014	129.5	-0.018	0.039
Cr^{6+}	79	79	0.000069	0.000063	91.4	-0.000057	0.000195
Specific Gravity	111	148	3.18	0.03	1.0	3.12	3.25
Specific surface	108	111	4820	154	3.2	4515	5125
Corrected surface	102	105	4807	148	3.1	4514	5100
Normal consistency	111	163	30.8	0.9	3.1	29.0	32.7
Initial setting time	116	168	187	19	10.3	149	225
Soundness	104	141	0.54	0.44	80.9	-0.32	1.40
Workability	5	8	8.7	13.9	160.5	-24.3	41.6
Granulométrie 2.5µm	56	56	14.3	3.8	26.6	6.7	22.0
Granulométrie 12.5µm	58	58	62.6	3.9	6.2	54.8	70.4
Granulométrie 31.5µm	62	65	96.0	2.1	2.2	91.8	100.2
Granulométrie 80µm	69	79	99.9	0.1	0.1	99.6	100.2
Shrinkage 3d	20	20	124	40	32.0	41	206
Shrinkage 7d	21	21	284	42	14.7	197	371
Shrinkage 14d	22	22	478	69	14.4	335	620
Shrinkage 28d	22	22	636	89	14.0	451	821
Swelling 3d	12	12	43	28	66.2	-20	106
Swelling 7d	12	12	64	53	83.3	-53	182
Swelling 14d	12	12	76	45	59.3	-23	175
Swelling 28d	13	13	70	36	51.8	-9	149
Heat of hydration 41h	35	35	331	20	6.1	290	371
Heat of hydration 3d	26	26	348	29	8.4	288	409
Heat of hydration 5d	25	25	354	30	8.4	293	415
Heat of hydration 7d	10	10	359	32	8.9	287	432
Maximum heat exhaust rate	9	15	29.4	3.5	11.9	21.9	36.9
Age maximum rate	9	15	8.8	0.7	8.3	7.2	10.4
Clinker	27	32	96.1	0.8	0.8	94.5	97.7
Set regulator	24	30	3.7	0.1	3.7	3.4	4.0
Constituent 1	16	20	0.8	1.1	139.2	-1.6	3.2
C3S Mineralogy	32	32	62.5	2.1	3.4	58.1	66.8
C2S Mineralogy	32	32	14.8	2.0	13.6	10.7	18.9
C3A Mineralogy	36	36	1.8	0.8	46.0	0.1	3.5
C4AF Mineralogy	35	35	14.1	1.1	7.6	11.9	16.3
Free Lime Mineralogy	30	30	1.0	0.4	42.6	0.1	1.8
SO4Ca Mineralogy	23	23	2.5	1.2	47.2	0.1	5.0
Mean of weight of samples at demoulding	104	104	584.6	5.0	0.9	574.7	594.5
Bending 1 day	54	54	4.3	0.4	8.6	3.6	5.1
Bending 2 days	54	54	5.9	0.3	5.9	5.2	6.5
Bending 7 days	55	55	7.5	0.5	6.1	6.6	8.4
Bending 28 days	55	55	8.3	0.4	4.8	7.5	9.1
Compression 1 day	116	134	19.4	0.9	4.4	17.7	21.1
Compression 2 days	127	147	31.1	1.1	3.6	28.9	33.3
Compression 7 days	124	144	50.1	1.8	3.6	46.5	53.7
Compression 28 days	130	151	64.0	2.3	3.5	59.6	68.5

4. Chemical Analysis





Loss on ignition - By population Group & Method

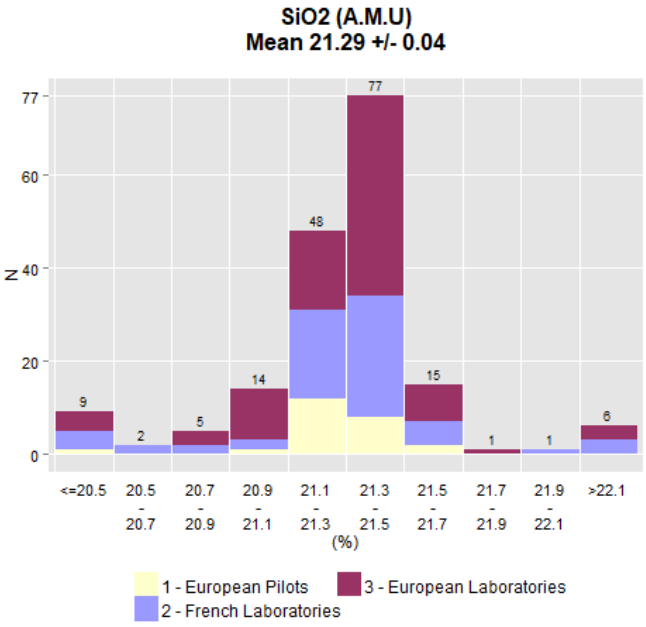
Population	Method	Number of Results	$\bar{x}$	ε	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots	A.M.U	20	**0.91**	0.04	0.10	10.5	**0.71**	**1.11**
2 - French Laboratories	A.M.U	76	**0.91**	0.02	0.11	11.8	**0.70**	**1.13**
3 - European Laboratories	A.M.U	84	**0.95**	0.03	0.13	13.1	**0.71**	**1.20**

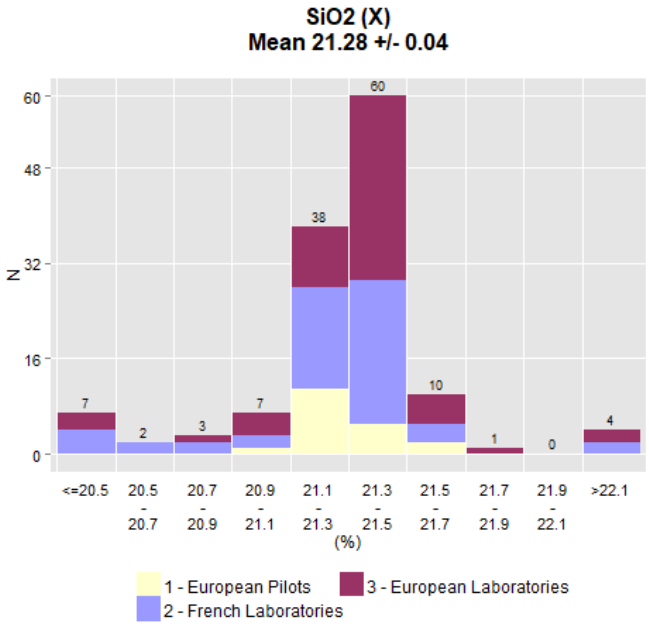
Population	Method	Number of Results	$\bar{x}$	ε	S_R	CV (%)	Lm95%	LM95%
1 – European pilots	K	15	**0.88**	0.05	0.09	10.0	**0.69**	**1.07**
1 – European pilots	N	3	**1.04**	0.04	0.02	1.7	**0.97**	**1.11**
2 - French Laboratories	D	4	**0.98**	0.39	0.25	25.0	**0.20**	**1.77**
2 - French Laboratories	K	67	**0.91**	0.02	0.10	10.7	**0.72**	**1.11**
2 - French Laboratories	N	3	**0.82**	0.14	0.06	6.8	**0.58**	**1.06**
3 - European Laboratories	D	4	**0.95**	0.25	0.15	16.2	**0.46**	**1.44**
3 - European Laboratories	K	67	**0.95**	0.03	0.13	13.3	**0.70**	**1.20**
3 - European Laboratories	N	11	**0.97**	0.07	0.11	11.0	**0.73**	**1.21**

Loss on Ignition - Eliminated Outliers
Confidence Level = 2%

N°Labo	Population	Method	Value
32	2 - French Laboratories	D	**1.40**
32	2 - French Laboratories	B	**1.40**
51	2 - French Laboratories	N	**0.35**
75	2 - French Laboratories	K	**1.44**
117	3 - European Laboratories	K	**1.48**
121	3 - European Laboratories	K	**1.42**
121	3 - European Laboratories	K	**1.51**
130	3 - European Laboratories	N	**1.36**
136	3 - European Laboratories	N	**2.51**

- Very satisfactory means whatever the population and the methods used.
- The mean A.M.U is 0,93 %. (see general summary table at the beginning of the report).





SiO_2 - By population Group & Method

Population	Method	Number of Results	$\bar{x}$	ε	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots	A.M.U	22	21.28	0.05	0.12	0.6	21.03	21.52
2 - French Laboratories	A.M.U	58	21.28	0.06	0.24	1.1	20.80	21.75
3 - European Laboratories	A.M.U	84	21.30	0.05	0.21	1.0	20.87	21.72

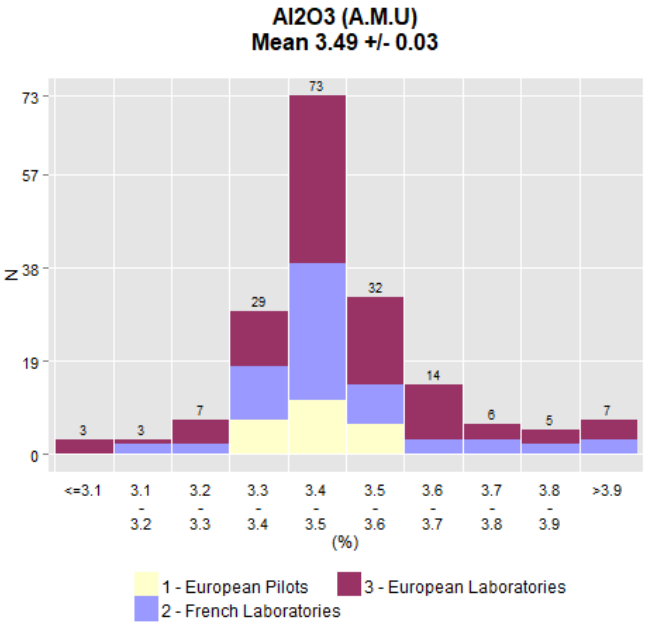
Population	Method	Number of Results	$\bar{x}$	ε	S_R	CV (%)	Lm95%	LM95%
1 - European pilots	K	4	21.35	0.14	0.09	0.4	21.07	21.63
1 - European pilots	X	18	21.26	0.06	0.12	0.6	21.01	21.51
2 - French Laboratories	X	51	21.25	0.06	0.22	1.0	20.81	21.69
2 - French Laboratories	M	5	21.44	0.22	0.18	0.8	20.95	21.94
2 – European laboratories	X	53	21.32	0.06	0.21	1.0	20.90	21.74
2 – European laboratories	K	29	21.24	0.08	0.22	1.0	20.80	21.68

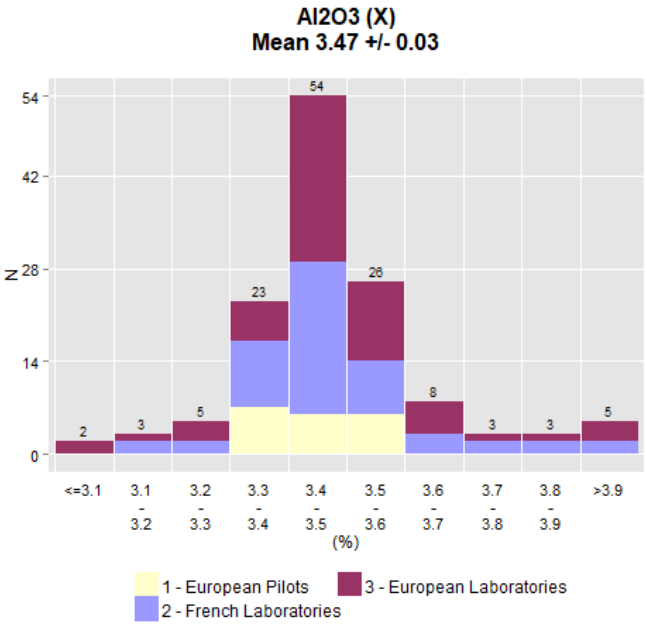
SiO_2 - Eliminated Outliers
Confidence Level = 2%

N°Lab	Population	Method	Value
8	1 - European pilots	K	20.33
12	1 - European pilots	X	21.66
51	2 - French Laboratories	X	22.95
51	2 - French Laboratories	X	23.10
55	2 - French Laboratories	X	19.52
82	2 - French Laboratories	X	17.55
82	2 - French Laboratories	X	17.53
86	2 - French Laboratories	M	25.66
119	3 - European Laboratories	M	19.04
129	3 - European Laboratories	X	23.29
133	3 - European Laboratories	K	22.25
135	3 - European Laboratories	X	20.10
136	3 - European Laboratories	X	19.32
139	3 - European Laboratories	X	22.67

- The overall mean for all methods used is 21,29 % (see general summary table at the beginning of the report).

- Overall, the results are very satisfactory for all three populations AMU and by methods.





Al_2O_3 - By population Group & Method

Population	Method	Number of Results	$\bar{x}$	ε	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots	A.M.U	24	**3.46**	0.03	0.07	2.0	**3.32**	**3.60**
2 - French Laboratories	A.M.U	60	**3.48**	0.04	0.15	4.3	**3.18**	**3.78**
3 - European Laboratories	A.M.U	87	**3.50**	0.03	0.15	4.2	**3.20**	**3.79**

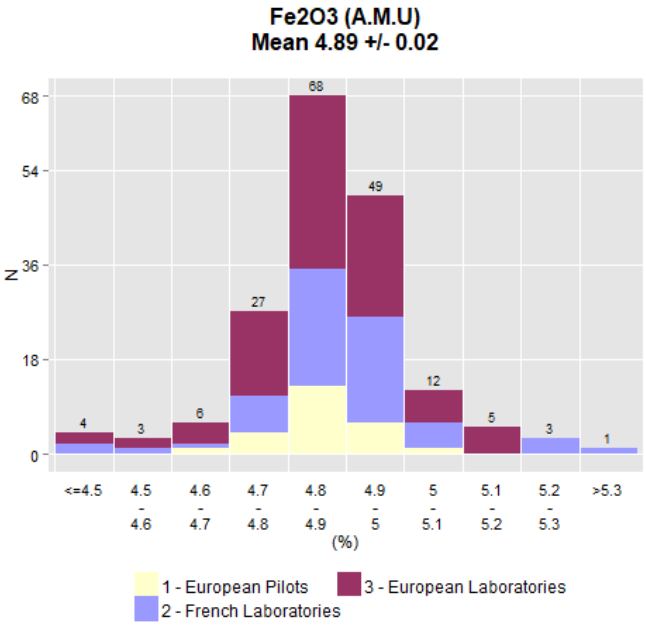
Population	Method	Number of Results	$\bar{x}$	ε	S_R	CV (%)	Lm95%	LM95%
1 - European pilots	X	19	**3.46**	0.04	0.08	2.2	**3.29**	**3.62**
1 - European pilots	K	5	**3.47**	0.03	0.02	0.7	**3.40**	**3.54**
2 - French Laboratories	X	52	**3.47**	0.04	0.14	3.9	**3.20**	**3.74**
2 - French Laboratories	M	6	**3.48**	0.15	0.15	4.2	**3.10**	**3.86**
2 - European laboratories	X	54	**3.48**	0.03	0.13	3.6	**3.23**	**3.73**
2 - European laboratories	K	28	**3.53**	0.07	0.19	5.3	**3.14**	**3.91**
2 - European laboratories	M	3	**3.56**	0.21	0.09	2.4	**3.19**	**3.93**

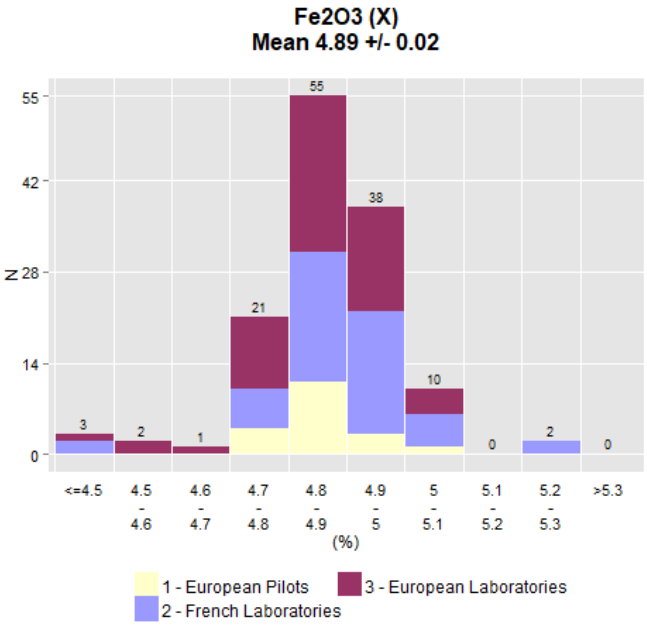
Al_2O_3 - Eliminated Outliers
Confidence Level = 2%

N°Lab	Population	Method	Value
37	2 - French Laboratories	X	**4.85**
133	3 - European Laboratories	K	**5.30**
135	3 - European Laboratories	X	**2.49**
135	3 - European Laboratories	X	**2.51**
136	3 - European Laboratories	X	**4.98**
138	3 - European Laboratories	X	**4.73**
138	3 - European Laboratories	X	**4.60**

- The overall mean for all methods used is 3,49 % for 171 tests (see general summary table at the beginning of the report).

- The results of the mean obtained are satisfactory whatever the method or the populations.





Fe_2O_3 - By population Group & Method

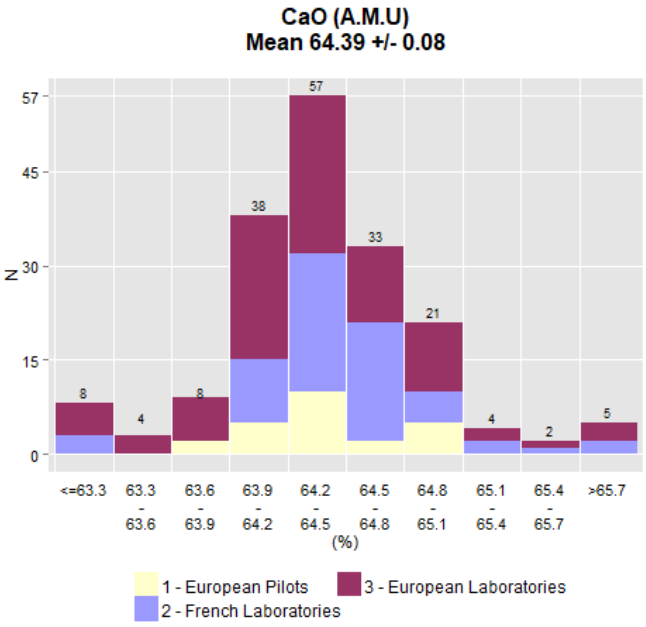
Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots	A.M.U	24	4.87	0.03	0.08	1.6	4.71	5.04
2 - French Laboratories	A.M.U	59	4.91	0.03	0.12	2.5	4.66	5.16
3 - European Laboratories	A.M.U	89	4.88	0.03	0.13	2.6	4.63	5.14

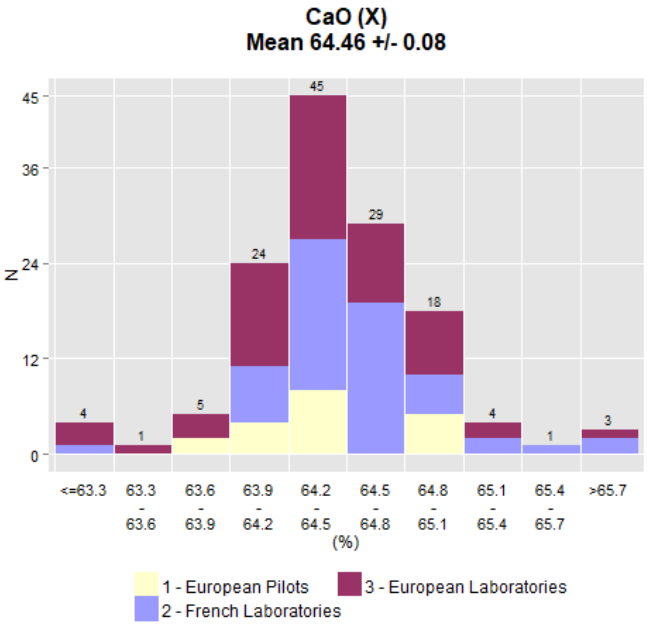
Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European pilots	X	19	4.86	0.04	0.08	1.6	4.70	5.03
1 - European pilots	K	4	4.94	0.07	0.05	0.9	4.80	5.09
2 - French Laboratories	X	52	4.92	0.03	0.11	2.2	4.70	5.13
2 - French Laboratories	M	5	4.90	0.25	0.20	4.1	4.34	5.45
3 - European Laboratories	X	58	4.87	0.03	0.11	2.2	4.65	5.09
3 - European Laboratories	K	26	4.90	0.06	0.16	3.2	4.57	5.23
3 - European Laboratories	M	3	4.88	0.21	0.09	1.8	4.51	5.25

Fe_2O_3 - Eliminated Outliers
Confidence Level = 2%

N°Lab	Population	Method	Value
2	1 - European Pilots	K	4.64
37	2 - French Laboratories	X	3.38
37	2 - French Laboratories	X	3.40
84	2 - French Laboratories	M	5.75
133	3 - European Laboratories	K	4.30
136	3 - European Laboratories	X	2.79

- The overall mean for all methods used is 4,89 % for 172 tests (see general summary table at the beginning of the report).
- The results of the mean obtained are very satisfactory whatever the method or the populations.





CaO - By population Group & Method

Population	Method	Number of Results	$\bar{x}$	ε	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots	A.M.U	24	64.41	0.15	0.36	0.6	63.67	65.15
2 - French Laboratories	A.M.U	60	64.48	0.10	0.38	0.6	63.71	65.25
3 - European Laboratories	A.M.U	86	64.32	0.10	0.48	0.7	63.36	65.28

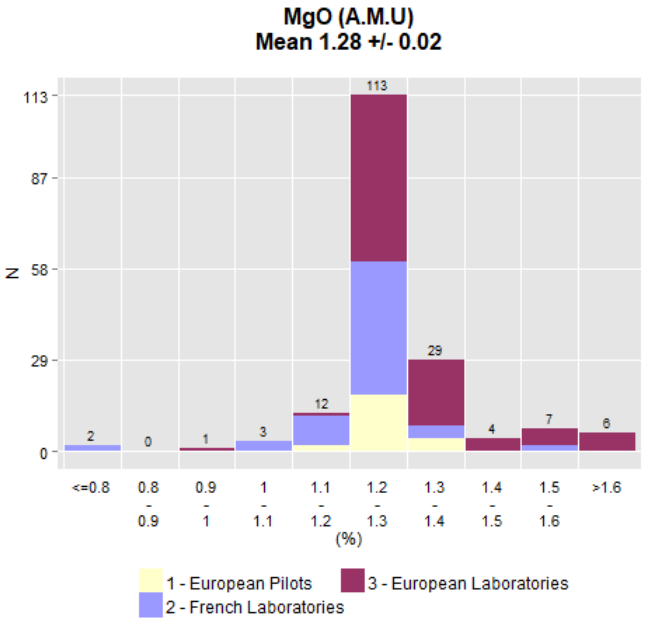
Population	Method	Number of Results	$\bar{x}$	ε	S_R	CV (%)	Lm95%	LM95%
1 - European pilots	X	19	64.41	0.19	0.40	0.6	63.58	65.25
1 - European pilots	K	5	64.39	0.24	0.19	0.3	63.85	64.93
2 - French Laboratories	X	53	64.54	0.08	0.30	0.5	63.95	65.14
2 - French Laboratories	M	5	64.30	0.21	0.17	0.3	63.83	64.76
3 - European laboratories	X	56	64.40	0.11	0.42	0.7	63.55	65.25
3 - European laboratories	K	26	64.20	0.21	0.52	0.8	63.14	65.27
3 - European laboratories	M	2	63.52	8.89	0.99	1.6	50.94	76.10

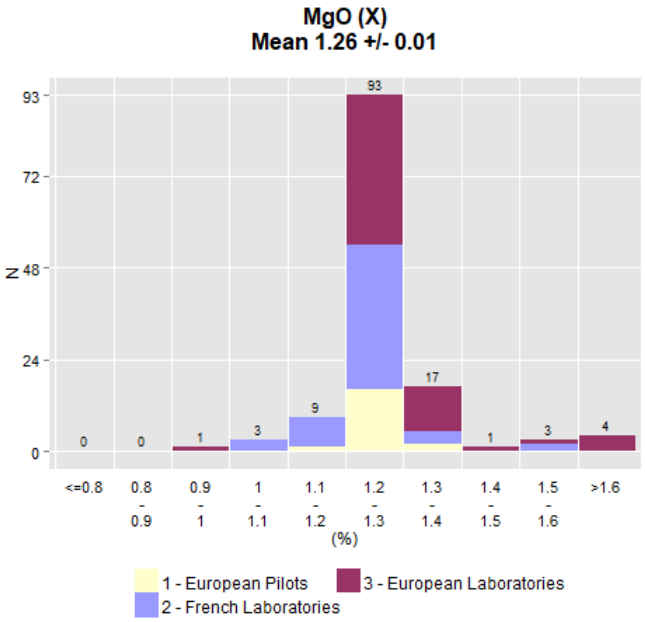
CaO - Eliminated Outliers
Confidence Level = 2%

N°Lab	Population	Method	Value
55	2 - French Laboratories	X	59.99
82	2 - French Laboratories	X	67.69
82	2 - French Laboratories	X	67.70
86	2 - French Laboratories	M	59.02
115	3 - European Laboratories	X	61.73
119	3 - European Laboratories	M	66.62
129	3 - European Laboratories	X	66.30
133	3 - European Laboratories	K	60.60
135	3 - European Laboratories	K	66.60
136	3 - European Laboratories	X	62.53

- The overall mean for all methods used is 64,39 % for 170 tests (see general summary table at the beginning of the report).

- The overall mean for all populations is satisfactory. Please note, a higher average in X-ray fluorescence for French laboratories compared to the other two populations (64,54% compared to 64,41% for European pilots and 64,40% for European laboratories).





MgO - By population Group & Method

Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots	A.M.U	24	**1.27**	0.02	0.05	3.6	**1.17**	**1.36**
2 - French Laboratories	A.M.U	58	**1.24**	0.01	0.06	4.5	**1.12**	**1.35**
3 - European Laboratories	A.M.U	86	**1.31**	0.02	0.10	7.4	**1.12**	**1.51**

Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European pilots	X	19	**1.26**	0.02	0.04	3.3	**1.17**	**1.35**
1 - European pilots	K	5	**1.28**	0.08	0.06	4.8	**1.11**	**1.45**
2 - French Laboratories	X	52	**1.23**	0.02	0.06	4.7	**1.12**	**1.35**
2 - French Laboratories	M	5	**1.25**	0.05	0.04	3.5	**1.13**	**1.37**
3 - European Laboratories	X	55	**1.30**	0.02	0.09	6.6	**1.13**	**1.47**
3 - European Laboratories	K	26	**1.34**	0.05	0.12	8.7	**1.10**	**1.58**
3 - European Laboratories	M	3	**1.26**	0.10	0.04	3.3	**1.08**	**1.44**

MgO - Eliminated Outliers
Confidence Level = 2%

N°Lab	Population	Method	Value
56	2 - French Laboratories	N	**0.79**
82	2 - French Laboratories	X	**1.60**
86	2 - French Laboratories	M	**0.71**
128	3 - European Laboratories	K	**1.91**
129	3 - European Laboratories	X	**0.99**
133	3 - European Laboratories	K	**1.95**
136	3 - European Laboratories	X	**1.94**
138	3 - European Laboratories	X	**1.66**
158	3 - European Laboratories	X	**1,81**
158	3 - European Laboratories	X	**1.84**

- The general mean is 1,28 %. Values lie between 1,11 % and 1,45 % (A.M.U). (see general summary table at the beginning of the report).
- The results of the mean obtained are very satisfactory.

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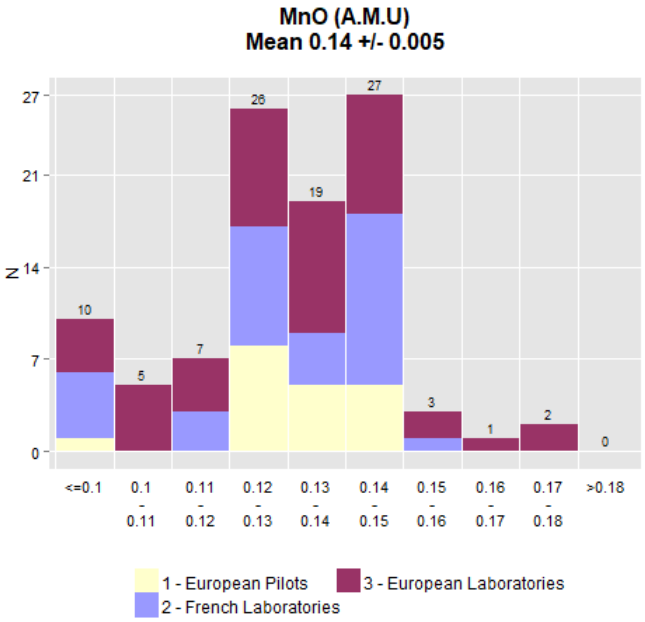
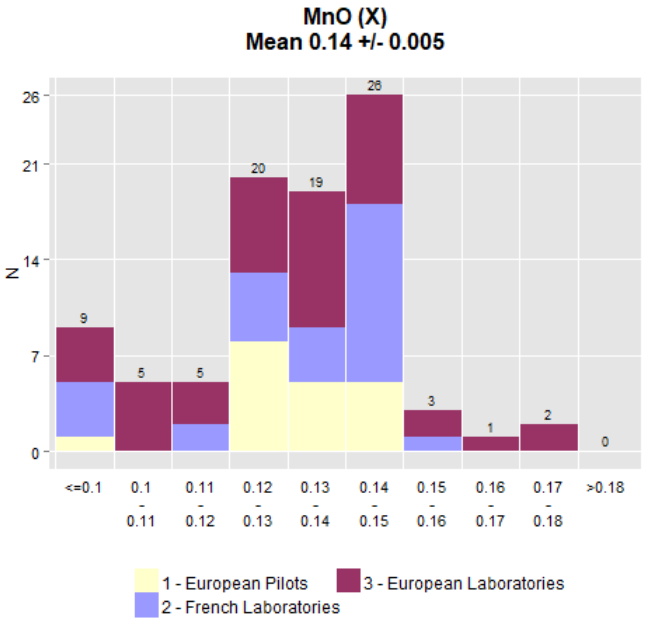




MnO - By population Group & Method

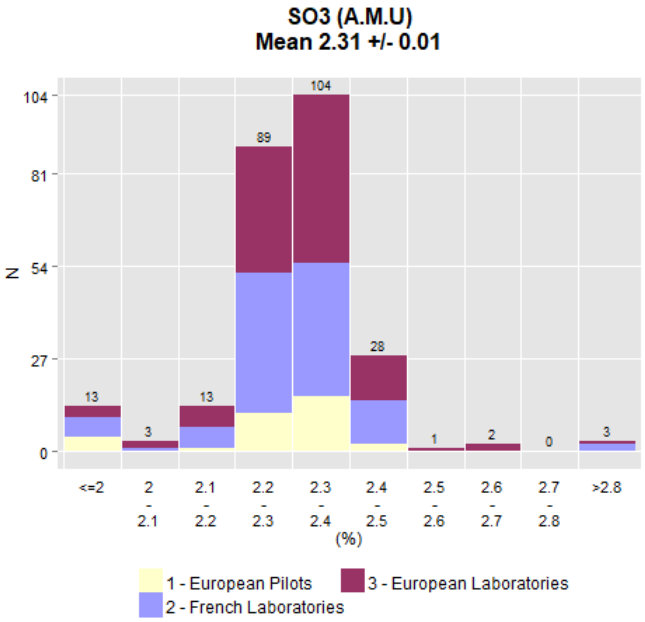
Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots	A.M.U	18	**0.14**	0.00	0.01	5.8	**0.12**	**0.15**
2 - French Laboratories	A.M.U	33	**0.13**	0.01	0.02	17.8	**0.08**	**0.18**
3 - European Laboratories	A.M.U	43	**0.14**	0.01	0.02	14.2	**0.10**	**0.17**

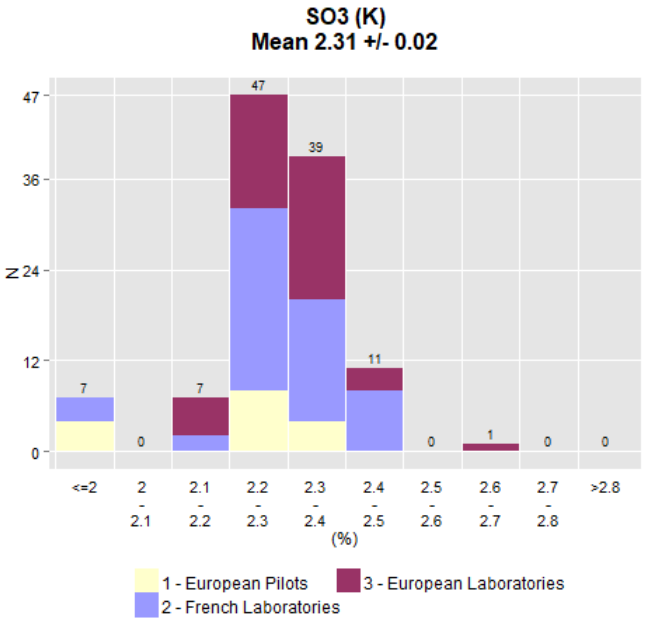
Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European pilots	X	18	**0.14**	0.00	0.01	5.8	**0.12**	**0.15**
2 - French Laboratories	X	27	**0.14**	0.01	0.02	16.7	**0.09**	**0.18**
2 - French Laboratories	N	6	**0.12**	0.03	0.02	20.3	**0.06**	**0.18**
3 - European Laboratories	X	39	**0.14**	0.01	0.02	14.7	**0.10**	**0.18**
3 - European Laboratories	N	4	**0.13**	0.02	0.01	9.5	**0.09**	**0.17**

MnO - Eliminated Outliers
Confidence Level = 2%

N°Lab	Population	Method	Value
4	1 - European Pilots	X	**0.08**
26	2 - French Laboratories	X	**0.04**
105	3 - European Laboratories	X	**0.00**
152	3 - European Laboratories	X	**0.06**

- The general mean is 0,14 % (see general summary table at the beginning of the report).
- The results of the mean obtained are very satisfactory whatever the method or the populations. High coefficients of variation which can be explained by low values on mean.





SO_3 - By population Group & Method

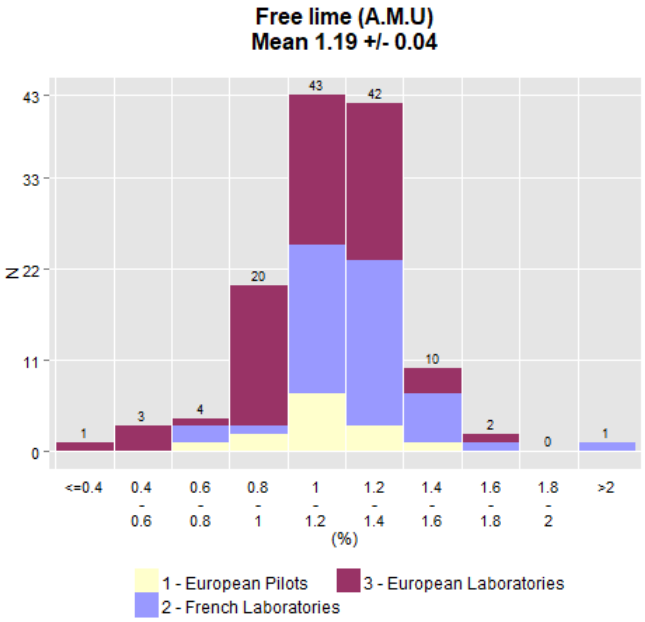
Population	Method	Number of Results	$\bar{x}$	ε	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots	A.M.U	31	2.31	0.03	0.08	3.7	2.14	2.48
2 - French Laboratories	A.M.U	101	2.30	0.02	0.08	3.7	2.14	2.47
3 - European Laboratories	A.M.U	110	2.32	0.02	0.09	3.9	2.14	2.50

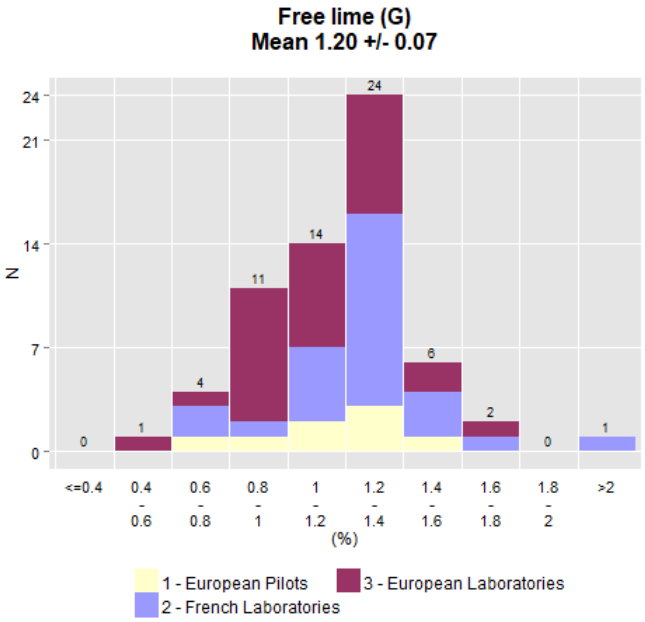
Population	Method	Number of Results	$\bar{x}$	ε	S_R	CV (%)	Lm95%	LM95%
1 - European pilots	X	15	2.34	0.04	0.08	3.3	2.17	2.50
1 - European pilots	K	13	2.28	0.06	0.10	4.2	2.07	2.49
1 - European pilots	N	3	2.32	0.04	0.02	0.7	2.26	2.39
2 - French Laboratories	K	50	2.31	0.02	0.08	3.3	2.16	2.47
2 - French Laboratories	X	42	2.29	0.03	0.09	4.0	2.10	2.47
2 - French Laboratories	N	9	2.34	0.06	0.08	3.4	2.16	2.52
3 - European Laboratories	X	52	2.31	0.03	0.11	4.6	2.10	2.53
3 - European Laboratories	K	42	2.31	0.02	0.08	3.4	2.15	2.46
3 - European Laboratories	N	16	2.36	0.03	0.06	2.6	2.23	2.49

SO_3 - Eliminated Outliers
Confidence Level = 2%

N°Lab	Population	Method	Value
13	1 - European pilots	K	1.71
13	1 - European pilots	K	1.85
14	1 - European pilots	K	1.87
51	2 - French Laboratories	X	1.80
51	2 - French Laboratories	X	1.86
75	2 - French Laboratories	K	1.76
82	2 - French Laboratories	X	3.14
82	2 - French Laboratories	X	3.13
84	2 - French Laboratories	K	1.91
84	2 - French Laboratories	K	1.93
120	3 - European Laboratories	N	1.63
121	3 - European Laboratories	K	2.63
129	3 - European Laboratories	X	1.83
136	3 - European Laboratories	X	3.41

- Overall results show excellent mean values for all methods used.
- The overall mean for all methods used is 2,31 % for 242 tests. (see general summary table at the beginning of the report).





Free lime - By population Group & Method

Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots	A.M.U	14	**1.13**	0.10	0.17	14.7	**0.77**	**1.49**
2 - French Laboratories	A.M.U	46	**1.27**	0.04	0.14	11.4	**0.98**	**1.56**
3 - European Laboratories	A.M.U	59	**1.14**	0.05	0.20	17.3	**0.74**	**1.53**

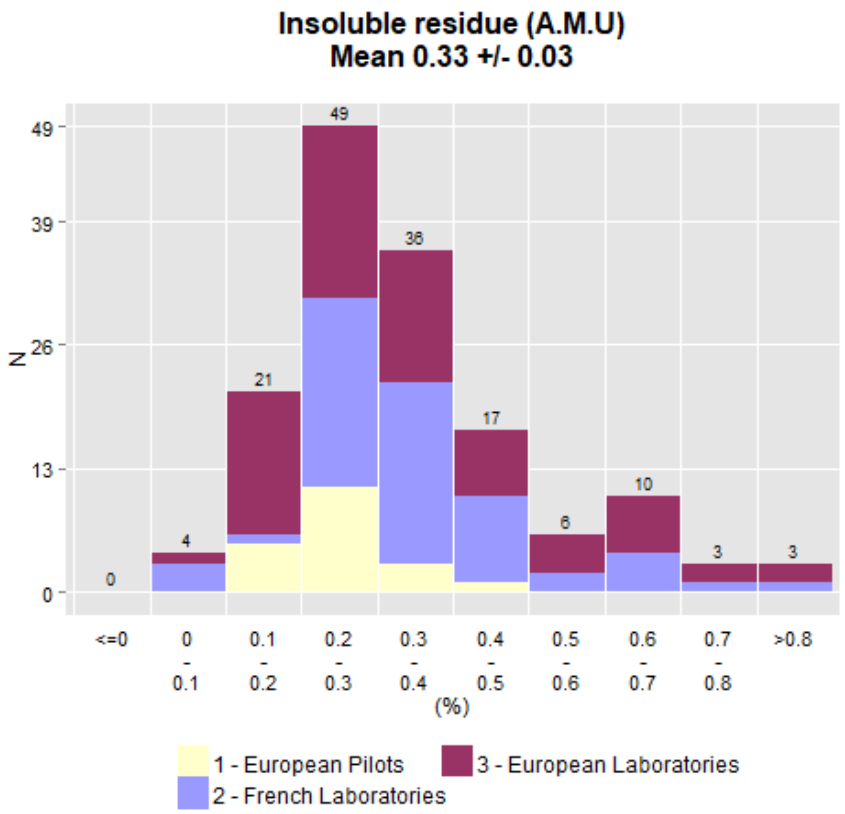
Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots	G	8	**1.16**	0.18	0.21	18.1	**0.66**	**1.65**
1 - European Pilots	C	6	**1.09**	0.09	0.08	7.7	**0.87**	**1.31**
2 - French Laboratories	G	23	**1.29**	0.06	0.15	11.3	**0.99**	**1.60**
2 - French Laboratories	C	18	**1.23**	0.06	0.12	10.0	**0.97**	**1.49**
2 - French Laboratories	N	4	**1.31**	0.37	0.23	17.5	**0.58**	**2.04**
3 - European Laboratories	G	28	**1.14**	0.09	0.24	20.6	**0.66**	**1.63**
3 - European Laboratories	C	20	**1.13**	0.08	0.17	14.7	**0.79**	**1.48**
3 - European Laboratories	N	10	**1.15**	0.10	0.14	12.0	**0.84**	**1.46**

Free lime - Eliminated Outliers
Confidence Level = 2%

N°Lab	Population	Method	Value
38	2 - French Laboratories	G	**0.73**
40	2 - French Laboratories	G	**0.65**
60	2 - French Laboratories	G	**2.03**
125	3 - European Laboratories	N	**0.50**
128	3 - European Laboratories	G	**0.41**
128	3 - European Laboratories	N	**0.42**
135	3 - European Laboratories	N	**0.40**

- As always, the results present high coefficients of variation. Please note that the mean (A.M.U) for French laboratories is higher than for the other two populations (1,27% compared with 1,13% for European pilots and 1,14% for European laboratories). The same dispersion is found whatever the method used.

- Though none of these methods are standardized, the overall mean value for all methods is 1,19 %.



Insoluble - By population Group & Method

Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots	A.M.U.	19	**0.25**	0.02	0.05	20.4	**0.14**	**0.35**
2 - French Laboratories	A.M.U.	58	**0.34**	0.03	0.13	36.9	**0.09**	**0.59**
3 - European Laboratories	A.M.U.	67	**0.34**	0.04	0.16	48.3	**0.01**	**0.67**

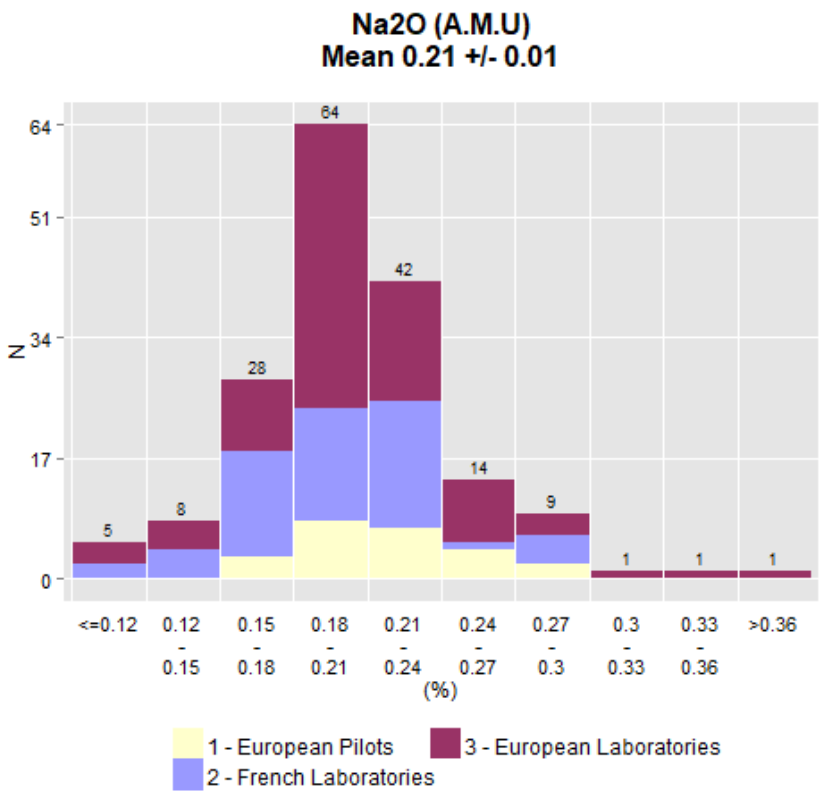
Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots	K	19	**0.25**	0.02	0.05	20.4	**0.14**	**0.35**
2 - French Laboratories	K	57	**0.34**	0.03	0.13	37.0	**0.09**	**0.60**
3 - European Laboratories	K	66	**0.34**	0.04	0.16	48.5	**0.01**	**0.66**

Insoluble - Eliminated Outliers
Confidence Level = 2%

N°Lab	Population	Method	Value
4	1 - European Pilots	K	**0.41**
24	2 - French Laboratories	K	**1.15**
31	2 - French Laboratories	K	**0.79**
126a	3 - European Laboratories	K	**1.58**
126a	3 - European Laboratories	K	**1.62**

- As always, the results present high coefficients of variation. Please note a higher mean A.M.U. and K for European pilots compared to the other two populations (0,25% compared to 0,34% for French and European laboratories).

- The overall mean for all methods used is 0,33 % for 144 tests with 98 % of the tests carried out according to the gravimetric method (see the general summary table at the beginning of the report).



Na_2O - By population Group & Method

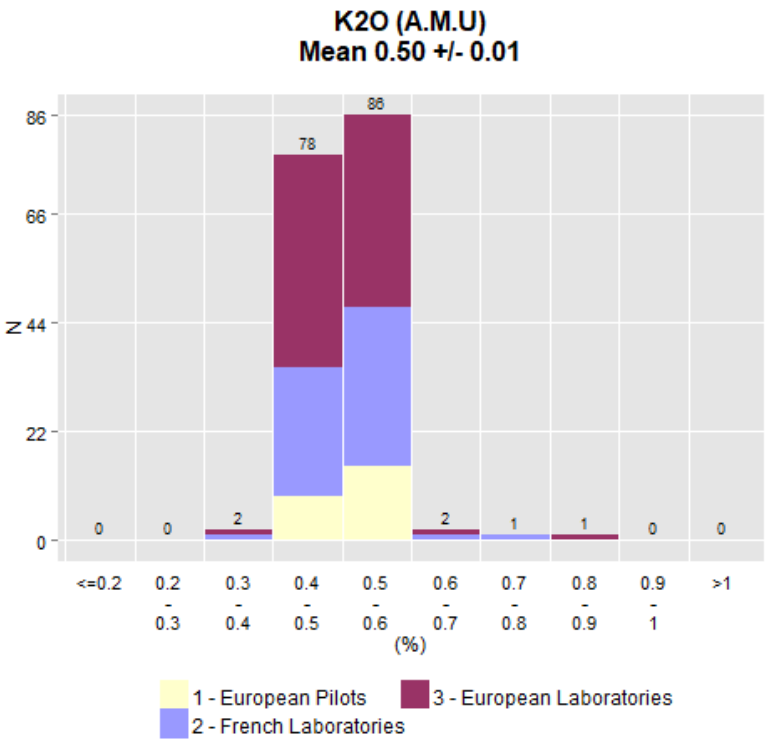
Population	Method	Number of Results	$\bar{x}$	ε	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots	A.M.U.	24	**0.22**	0.02	0.04	16.1	**0.15**	**0.30**
2 - French Laboratories	A.M.U.	59	**0.20**	0.01	0.04	17.6	**0.13**	**0.27**
3 - European Laboratories	A.M.U.	84	**0.21**	0.01	0.03	15.9	**0.14**	**0.27**

Population	Method	Number of Results	$\bar{x}$	ε	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots	X	17	**0.21**	0.02	0.03	14.3	**0.15**	**0.28**
1 - European Pilots	K	6	**0.23**	0.04	0.04	17.3	**0.13**	**0.34**
2 - French Laboratories	X	50	**0.20**	0.01	0.04	18.0	**0.13**	**0.27**
2 - French Laboratories	K	5	**0.22**	0.01	0.00	2.0	**0.21**	**0.23**
2 - French Laboratories	M	4	**0.24**	0.05	0.03	11.8	**0.15**	**0.33**
3 - European Laboratories	X	54	**0.21**	0.01	0.03	16.0	**0.14**	**0.27**
3 - European Laboratories	K	21	**0.20**	0.02	0.03	17.4	**0.13**	**0.27**
3 - European Laboratories	A	5	**0.22**	0.04	0.03	15.4	**0.13**	**0.31**

Na_2O - Eliminated Outliers
Confidence Level = 2%

Labo	Groupe de Labo	Méthode	Valeur
55	2 - French Laboratories	X	**0.11**
100	3 - European Laboratories	K	**0.33**
100	3 - European Laboratories	K	**0.34**
100	3 - European Laboratories	M	**0.43**
129	3 - European Laboratories	X	**0.09**
135	3 - European Laboratories	X	**0.11**

- Homogeneous mean for most methods used: flame photometry and X-ray fluorescence.
  The general mean for Na_2O is 0,21 %.



K_2O - By population Group & Method

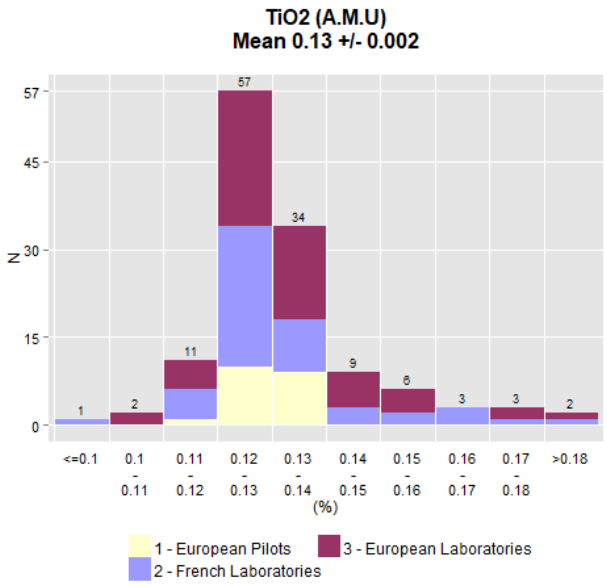
Population	Method	Number of Results	$\bar{x}$	ε	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots	A.M.U.	22	**0.51**	0.01	0.02	3.4	**0.48**	**0.55**
2 - French Laboratories	A.M.U.	59	**0.51**	0.01	0.03	5.6	**0.45**	**0.56**
3 - European Laboratories	A.M.U.	82	**0.50**	0.01	0.03	6.8	**0.43**	**0.57**

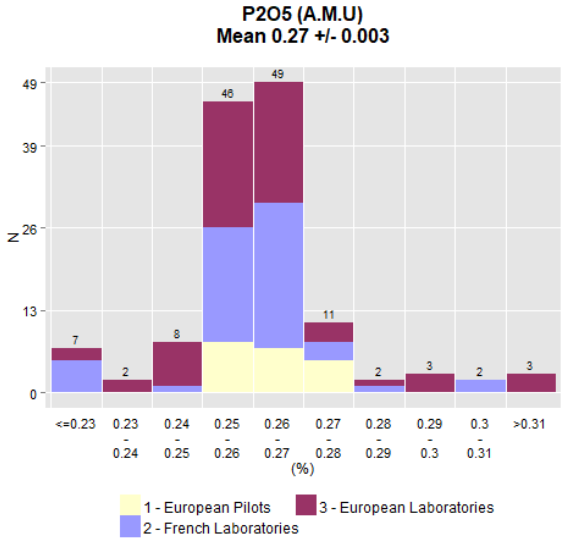
Population	Method	Number of Results	$\bar{x}$	ε	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots	X	17	**0.51**	0.01	0.02	3.1	**0.48**	**0.54**
1 - European Pilots	K	4	**0.51**	0.01	0.01	1.0	**0.49**	**0.52**
2 - French Laboratories	X	50	**0.51**	0.01	0.03	5.2	**0.45**	**0.56**
2 - French Laboratories	K	4	**0.48**	0.03	0.02	3.5	**0.43**	**0.54**
2 - French Laboratories	M	4	**0.50**	0.08	0.05	10.5	**0.34**	**0.67**
3 - European Laboratories	X	60	**0.50**	0.01	0.03	6.4	**0.44**	**0.56**
3 - European Laboratories	K	11	**0.49**	0.02	0.03	5.3	**0.43**	**0.55**

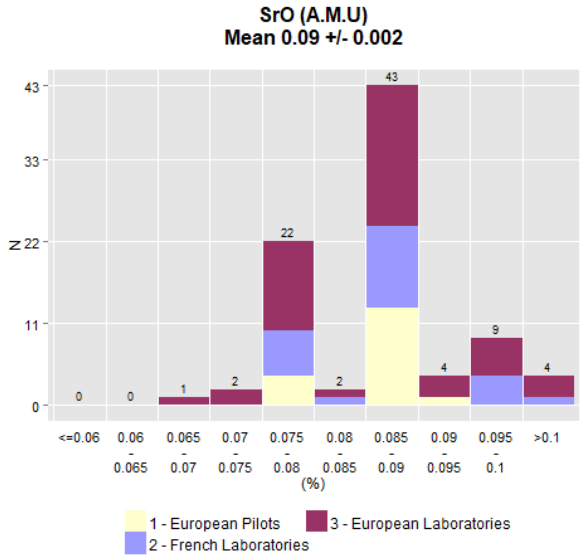
K_2O - Eliminated Outliers
Confidence Level = 2%

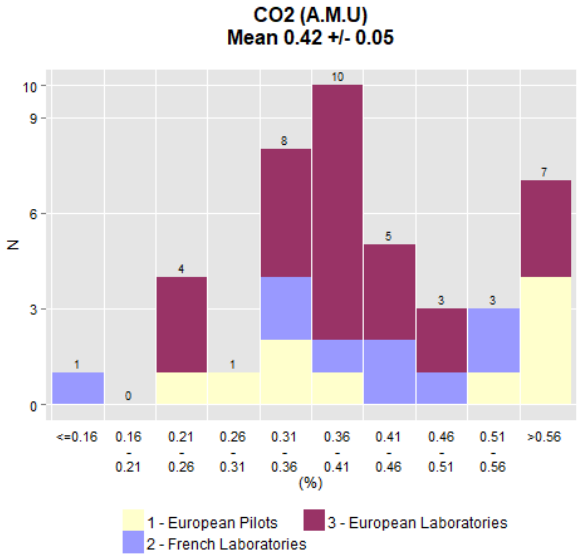
Lab	Population	Method	Value
2	1 - European Pilots	K	**0.44**
2a	1 - European Pilots	K	**0.44**
21	2 - French Laboratories	X	**0.78**
55	2 - French Laboratories	X	**0.36**
100	3 - European Laboratories	K	**0.68**
120	3 - European Laboratories	K	**0.34**
136	3 - European Laboratories	X	**0.87**

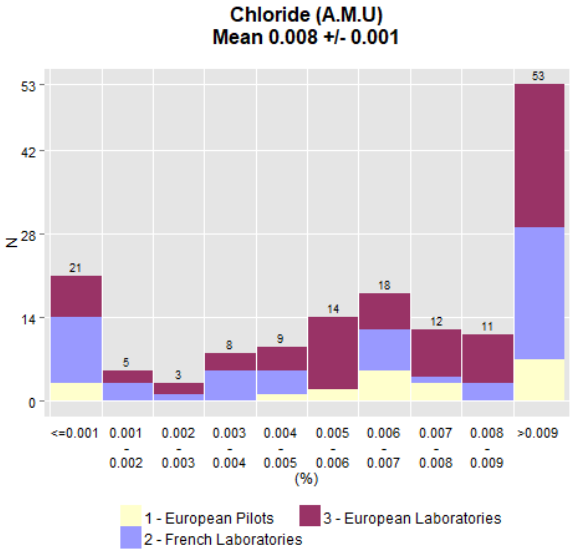
- Homogeneous mean for most methods used: flame photometry and X-ray fluorescence.
  The general mean for K_2O is 0,50 %.

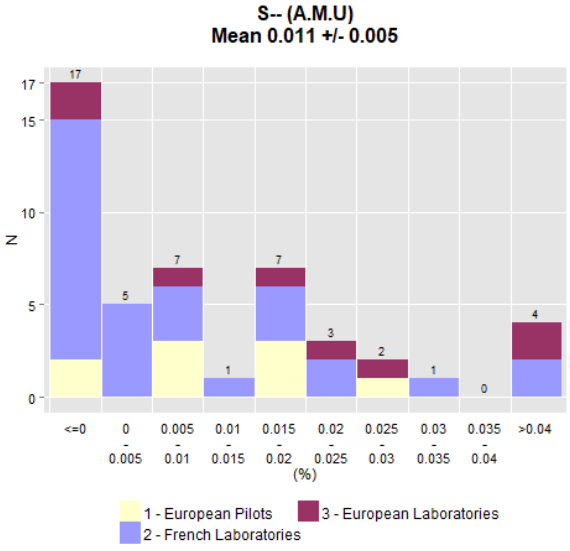

TiO2 (A.M.U)
Mean 0.13 +/- 0.002
N
(%)
1 - European Pilots
2 - French Laboratories
3 - European Laboratories


P2O5 (A.M.U)
Mean 0.27 +/- 0.003
N
(%)
1 - European Pilots
2 - French Laboratories
3 - European Laboratories


SrO (A.M.U)
Mean 0.09 +/- 0.002
N
(%)
1 - European Pilots
2 - French Laboratories
3 - European Laboratories


CO2 (A.M.U)
Mean 0.42 +/- 0.05
N
(%)
1 - European Pilots
2 - French Laboratories
3 - European Laboratories


Chloride (A.M.U)
Mean 0.008 +/- 0.001
N
(%)
1 - European Pilots
2 - French Laboratories
3 - European Laboratories


S-- (A.M.U)
Mean 0.011 +/- 0.005
N
(%)
1 - European Pilots
2 - French Laboratories
3 - European Laboratories

TiO_2 - By population Group & Method

Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots	A.M.U.	20	**0.13**	0.00	0.01	4.5	**0.12**	**0.15**
2 - French Laboratories	A.M.U.	46	**0.14**	0.00	0.01	9.6	**0.11**	**0.16**
3 - European Laboratories	A.M.U.	58	**0.14**	0.00	0.01	10.3	**0.11**	**0.16**

TiO_2 - Eliminated Outliers
Confidence Level = 2%

N° Lab	Population	Method	Value
35	2 - French Laboratories	X	**0.19**
35	2 - French Laboratories	X	**0.18**
86	2 - French Laboratories	N	**0.07**
136	3 - European Laboratories	X	**0.34**

P_2O_5 - By population Group & Method

Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots	A.M.U.	20	**0.27**	0.00	0.01	2.9	**0.25**	**0.28**
2 - French Laboratories	A.M.U.	50	**0.27**	0.00	0.01	5.0	**0.24**	**0.29**
3 - European Laboratories	A.M.U.	58	**0.27**	0.00	0.02	6.6	**0.23**	**0.30**

P_2O_5 - Eliminated Outliers
Confidence Level = 2%

N° Lab	Population	Method	Value
82	2 - French Laboratories	X	**0.09**
82	2 - French Laboratories	X	**0.08**
86	2 - French Laboratories	N	**0.18**
128	3 - European Laboratories	N	**0.16**
136	3 - European Laboratories	X	**0.47**
158	3 - European Laboratories	X	**0.56**
158	3 - European Laboratories	X	**0.67**

SrO - By population Group & Method

Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots	A.M.U.	18	**0.09**	0.00	0.00	4.9	**0.08**	**0.10**
2 - French Laboratories	A.M.U.	22	**0.09**	0.00	0.01	8.0	**0.07**	**0.10**
3 - European Laboratories	A.M.U.	43	**0.09**	0.00	0.01	8.6	**0.07**	**0.10**

SrO - Eliminated Outliers
Confidence Level = 2%

N° Lab	Population	Method	Value
82	2 - French Laboratories	X	**0.11**
128	3 - European Laboratories	N	**0.26**
131	3 - European Laboratories	X	**0.16**
131	3 - European Laboratories	X	**0.13**

CO_2 - By population Group & Method

Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots	A.M.U.	9	**0.44**	0.13	0.17	37.9	**0.06**	**0.83**
2 - French Laboratories	A.M.U.	8	**0.44**	0.06	0.07	16.8	**0.27**	**0.62**
3 - European Laboratories	A.M.U.	22	**0.40**	0.05	0.11	26.5	**0.18**	**0.62**

CO_2 - Eliminated Outliers
Confidence Level = 2%

N° Lab	Population	Method	Value
11	1 - European Pilots		**0.93**
32	2 - French Laboratories		**0.00**
130	3 - European Laboratories		**0.96**

Chlorure - By population Group & Method

Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots	A.M.U.	20	**0.010**	0.004	0.008	79.4	**-0.006**	**0.026**
2 - French Laboratories	A.M.U.	55	**0.007**	0.001	0.005	74.3	**-0.003**	**0.017**
3 - European Laboratories	A.M.U.	74	**0.008**	0.001	0.005	62.1	**-0.002**	**0.018**

Chlorure - Eliminated Outliers
Confidence Level = 2%

N° Lab	Population	Method	Value
2	1 - European Pilots	X	**0.040**
38	2 - French Laboratories	P	**0.044**
76	2 - French Laboratories	N	**0.030**
101	3 - European Laboratories	X	**0.055**
136	3 - European Laboratories	M	**0.072**

S^{--} - By population Group & Method

Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots	A.M.U.	9	**0.013**	0.008	0.010	77.5	**-0.010**	**0.036**
2 - French Laboratories	A.M.U.	29	**0.008**	0.005	0.013	157.8	**-0.018**	**0.034**
3 - European Laboratories	A.M.U.	7	**0.020**	0.019	0.021	102.6	**-0.030**	**0.071**

S^{--} - Eliminated Outliers
Confidence Level = 2%

Lab	Population	Method	Value
26	2 - French Laboratories	P	**0.100**
143	3 - European Laboratories	K	**0.072**

Cr^{6+} - By population Group & Method

Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots	A.M.U.	9	**0.000052**	0.000028	0.000037	70.2	**-0.00003**	**0.000137**
2 - French Laboratories	A.M.U.	32	**0.000064**	0.000023	0.000065	100.6	**-0.00007**	**0.000196**
3 - European Laboratories	A.M.U.	38	**0.000077**	0.000022	0.000067	86.5	**-0.00006**	**0.000213**

Cr^{6+} - Eliminated Outliers
Confidence Level = 2%

N° Lab	Population	Method	Value
32	2 - French Laboratories	N	**0.300000**
117	3 - European Laboratories		**0.000461**
125	3 - European Laboratories	K	**0.000533**

5. Remarks on the Chemical Analysis

- This year's cement was a **CEM I 52,5 N.**

- Mean results for the three groups are very satisfactory. We note homogeneous results for the major elements, whatever the method used or the group.

- Considering the whole of the proportioning and determinations liable to be done using X-ray fluorescence spectrometry, we note that **76 %** of the tests were indeed done using this method. This figure is stable compared to the previous year. Variations in the free lime contents are mainly due to a lack of standard operating procedure.

- Low contents tests usually display high coefficients of variation showing an important dispersion. This is the case in particular of the chromium VI content. This is due to the fact that the content values are close to the detection limits and the values are small in relation to the precision of the method.

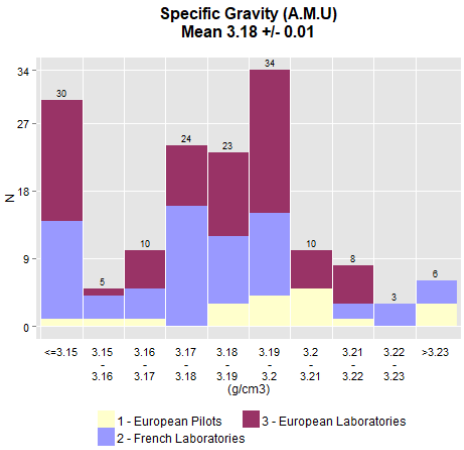
We can also report:

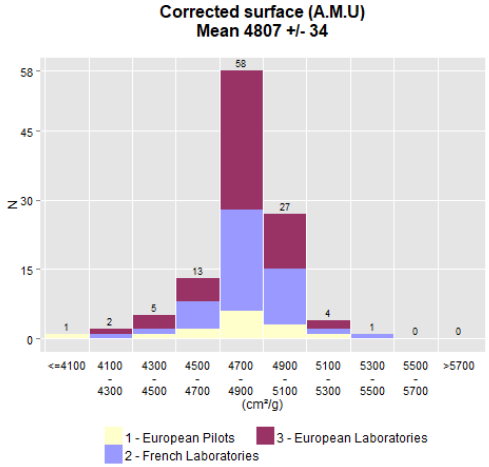
- For the determination of CaO, a higher mean in X-ray fluorescence for French laboratories compared to the other two populations (**64.54 %** compared to **64.41 %** for European pilots and 64.40 % for European laboratories).

- A significant difference on the means for the determination of free lime (A.M.U.) for French laboratories, compared to the other two populations (**1.27 %** compared to **1.13 %** for European pilots and **1.14 %** for European laboratories).

- For the determination of insoluble residue, a higher mean (A.M.U.) and for the CEN (K) method for European pilots compared to the other two populations (**0.25 %** compared to **0.34 %** for French and European laboratories).

6. Physical measurement and Physical tests





Specific gravit - By population Group & Method

Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots	A.M.U.	18	**3.20**	0.02	0.03	1.0	**3.14**	**3.27**
2 - French Laboratories	A.M.U.	62	**3.18**	0.01	0.03	1.0	**3.11**	**3.25**
3 - European Laboratories	A.M.U.	68	**3.18**	0.01	0.03	0.9	**3.12**	**3.24**

Specific gravity - Eliminated Outliers
Confidence Level = 2%

N° Lab	Population	Method	Value
2	1 - European Pilots	A	**3.29**
32	2 - French Laboratories	V	**2.71**
41	2 - French Laboratories	V	**3.05**
75	2 - French Laboratories	V	**3.08**
120	3 - European Laboratories	A	**3.02**
122	3 - European Laboratories	V	**3.05**

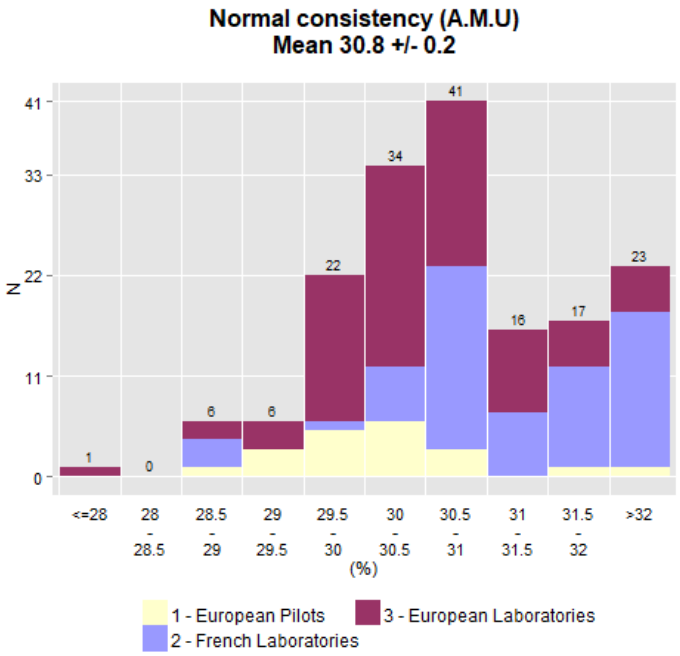
Corrected surface - By population Group & Method

Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots	A.M.U.	13	**4790**	120	198	4.1	**4358**	**5221**
2 - French Laboratories	A.M.U.	42	**4821**	46	146	3.0	**4526**	**5117**
3 - European Laboratories	A.M.U.	50	**4801**	39	136	2.8	**4527**	**5074**

Corrected surface - Eliminated Outliers
Confidence Level = 2%

N° Lab	Population	Method	Value
10	1 - European Pilots		**4016**
10	2 - French Laboratories		**5865**
32	2 - French Laboratories		**3846**
55	2 - French Laboratories		**4162**
71	2 - French Laboratories		**5330**
73	3 - European Laboratories		**6340**
73b	3 - European Laboratories		**6520**
75	3 - European Laboratories		**3763**
123	3 - European Laboratories		**4296**
136	3 - European Laboratories		**4374**
149	3 - European Laboratories		**5234**

- There are a significant number of values below 3.15 g/cm^3 for specific gravity determination.
- A French standard is in the process of being approved for determining the specific gravity. Specific surface area determination is described in European standard NF EN 196-6.
- Errors in determining density affect specific surface area measurement, both in the porosity of the powder layer, and in the computation of the results. To amend this, we have corrected specific surface values with the difference between the density determined by the laboratory and the computed mean value, so that specific surfaces given here are corrected specific surfaces.



Normal consistency - By population Group

Population	Method	Number of Results	$\bar{x}$	ε	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots	A.M.U.	20	**30.2**	0.4	0.9	2.8	**28.4**	**32.0**
2 - French Laboratories	A.M.U.	63	**31.3**	0.2	0.9	3.0	**29.4**	**33.1**
3 - European Laboratories	A.M.U.	80	**30.6**	0.2	0.8	2.7	**29.0**	**32.3**

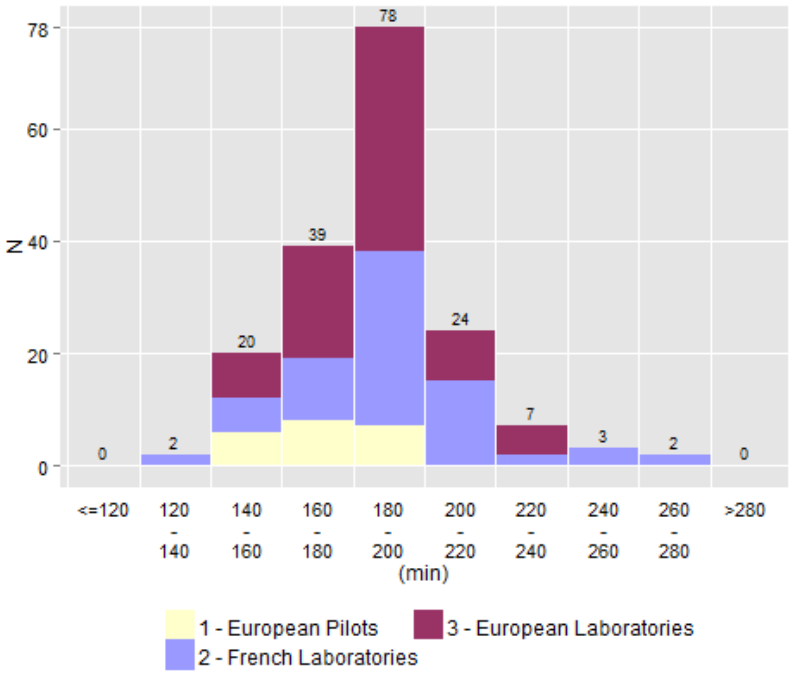
Normal consistency - Eliminated Outliers
Confidence Level = 2%

N° Lab	Population	Method	Value
40	2 - French Laboratories		**34.2**
136	3 - European Laboratories		**25.9**

- The results obtained for the test on the normal consistency give slightly scattered means over all the populations with a slightly higher mean for the French laboratories (31.3% against 30.2% for the European pilots and 30.6% for the European laboratories).

- The normal consistency is described in European standard NF EN 196-3.

Initial setting time (A.M.U)
Mean 187 +/- 3



Initial setting time
By population Group & Method

Population	Method	Number of Results	$\bar{x}$	ε	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots	A.M.U.	21	171	7	16	9.2	138	204
2 - French Laboratories	A.M.U.	68	191	5	21	10.8	150	232
3 - European Laboratories	A.M.U.	79	187	4	17	8.9	154	221

Population	Method	Number of Results	$\bar{x}$	ε	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots	A	18	169	8	16	9.6	135	203
2 - French Laboratories	A	50	190	5	19	10.2	151	229
2 - French Laboratories	M	18	192	12	24	12.6	141	243
3 - European Laboratories	A	60	187	4	16	8.7	155	220
3 - European Laboratories	M	19	187	9	18	9.8	149	226

Initial setting time - Eliminated Outliers
Confidence Level = 2%

N° Lab	Population	Method	Value
54	2 - French Laboratories	M	245
54	2 - French Laboratories	M	253
85	2 - French Laboratories	A	275
117	3 - European Laboratories	M	240
124	3 - European Laboratories	A	232
143	3 - European Laboratories	A	142

- The results obtained for the initial setting time test are homogeneous for all populations.
- The initial setting time is described in European standard NF EN 196-3.

Soundness - By population Group

Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots		19	**0.42**	0.24	0.50	119.6	**-0.63**	**1.47**
2 - French Laboratories		52	**0.50**	0.12	0.43	85.6	**-0.36**	**1.37**
3 - European Laboratories		70	**0.60**	0.10	0.42	69.7	**-0.23**	**1.43**

Soundness - Eliminated Outliers
Confidence Level = 2%

N° Lab	Population	Method	Value
3	1 - European Pilots		**1.90**
25	2 - French Laboratories		**2.00**
83d	2 - French Laboratories		**2.00**

- 141 determinations have been done. The standard is NF EN 196-3. The mean AMU is **0,54 mm ± 0,44** a low value, due to the low content in free lime.

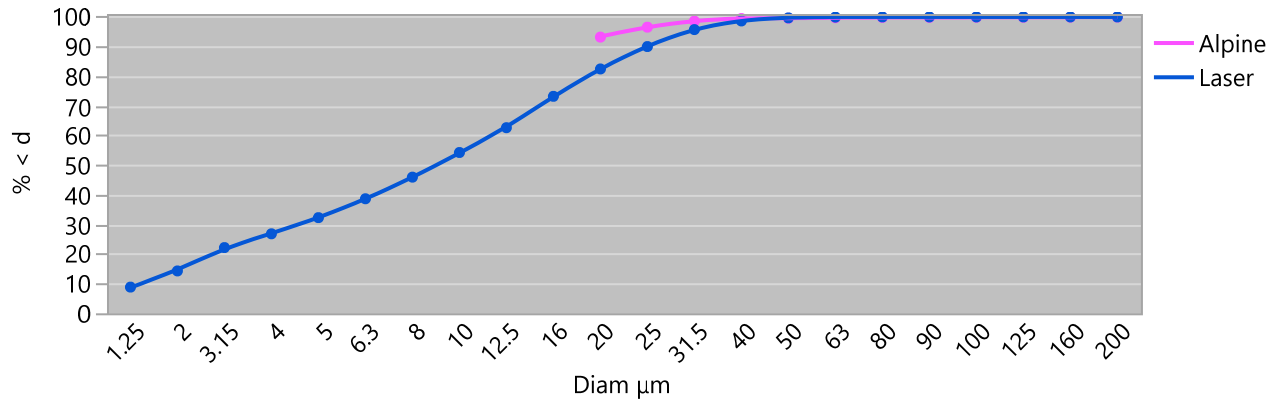
Workability - By population Group

Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
2 - French Laboratories		8	**8.7**	11.6	13.9	160.5	**-24.3**	**41.6**

Fluidity - By population Group

Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
2 - French Laboratories		1	**5.6**					

7. Granulometry - Alpine / Laser



Granulometry all population and all methods used - By Alpine sieving and laser particle size

	Sieve																					
	1.25	2	3.15	4	5	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	90	100	125	160	200
	Mean x̄																					
Alpine											93.2	96.6	98.6	99.5	99.6	99.7	99.8	99.8	99.9	99.9	99.9	99.9
Laser	8.8	14.3	22.2	26.8	32.3	38.7	46.0	54.3	62.6	73.2	82.4	90.0	95.7	98.6	99.7	99.9	100.0	100.0	100.0	100.0	100.0	100.0

Granulometry – By population AMU

	Labo Group																	
	1 - European Pilots						2 - European Laboratories						3 - Foreign Laboratories					
	Mean	Ɛ (5%)	Repro Std	CV (%)	Lm95 %	LM95 %	Mean	Ɛ (5%)	Repro Std	CV (%)	Lm95 %	LM95 %	Mean	Ɛ (5%)	Repro Std	CV (%)	Lm95 %	LM95 %
Dimension	A.M.U						A.M.U						A.M.U					
1.25	8.9	3.8	4.1	46.5	-1.2	19.1	9.9	1.3	2.8	28.6	4.0	15.8	8.0	1.3	3.3	41.6	1.1	14.9
2	14.1	4.3	4.6	32.7	2.8	25.3	15.5	1.7	3.5	22.8	8.1	22.9	13.6	1.4	3.7	27.4	5.9	21.2
3.15	21.6	4.0	4.3	20.0	11.0	32.2	24.0	1.8	3.7	15.6	16.2	31.9	21.1	1.6	4.4	20.8	12.1	30.1
4	26.7	3.9	4.3	16.0	16.3	37.1	28.0	2.2	4.8	17.2	17.9	38.0	26.1	1.7	4.6	17.5	16.8	35.4
5	32.6	3.6	3.9	12.1	23.0	42.2	33.4	2.1	4.8	14.3	23.4	43.3	31.4	1.6	4.4	14.0	22.4	40.5
6.3	39.2	3.5	3.8	9.7	29.9	48.5	39.6	2.2	4.9	12.5	29.3	49.8	37.9	1.5	4.2	11.1	29.3	46.5
8	46.5	3.8	4.1	8.8	36.5	56.6	46.6	1.5	3.4	7.2	39.6	53.6	45.4	1.5	4.0	8.9	37.2	53.6
10	54.8	3.4	3.7	6.7	45.8	63.8	55.3	1.6	3.6	6.6	47.7	62.8	53.4	1.4	3.8	7.0	45.8	61.1
12.5	61.4	5.7	6.1	10.0	46.4	76.4	63.8	1.8	4.0	6.2	55.6	72.1	62.1	1.2	3.1	5.0	55.8	68.4
16	73.8	4.0	4.4	5.9	63.2	84.5	73.6	2.1	4.7	6.4	63.8	83.4	72.8	1.1	2.8	3.8	67.1	78.4
20	82.0	4.7	5.1	6.2	69.6	94.5	83.0	2.2	5.1	6.2	72.4	93.7	82.8	1.4	3.8	4.6	75.0	90.6
25	89.1	4.7	5.1	5.7	76.6	101.7	90.8	1.9	4.6	5.1	81.3	100.4	90.5	1.0	3.0	3.3	84.4	96.6
31.5	96.8	1.7	1.9	1.9	92.2	101.3	96.1	1.0	2.5	2.6	91.0	101.2	95.8	0.7	1.9	2.0	91.9	99.7
40	99.3	0.5	0.7	0.7	97.9	100.8	98.9	0.3	1.0	1.0	96.9	100.8	98.8	0.3	1.0	1.0	96.9	100.8
50	99.8	0.1	0.1	0.1	99.5	100.2	99.5	0.1	0.4	0.4	98.8	100.3	99.6	0.1	0.4	0.4	98.8	100.5
63	99.9	0.1	0.1	0.1	99.6	100.2	99.8	0.1	0.1	0.1	99.6	100.1	99.8	0.1	0.2	0.2	99.4	100.3
80	99.9	0.1	0.1	0.1	99.7	100.1	99.9	0.0	0.1	0.1	99.7	100.2	99.9	0.0	0.1	0.1	99.6	100.2
90	99.9	0.1	0.1	0.1	99.7	100.1	99.9	0.0	0.1	0.1	99.7	100.1	99.9	0.0	0.1	0.1	99.8	100.1
100	99.9	0.1	0.1	0.1	99.8	100.1	100.0	0.0	0.0	0.0	99.9	100.1	100.0	0.0	0.1	0.1	99.8	100.1
125	99.9	0.1	0.1	0.1	99.8	100.1	100.0	0.0	0.0	0.0	99.9	100.1	100.0	0.0	0.1	0.1	99.8	100.1
160	100.0	0.0	0.0	0.0	99.9	100.1	100.0	0.0	0.0	0.0	99.9	100.1	100.0	0.0	0.1	0.1	99.9	100.1
200	100.0	0.0	0.0	0.0	99.9	100.1	100.0	0.0	0.0	0.0	99.9	100.0	100.0	0.0	0.1	0.1	99.9	100.1

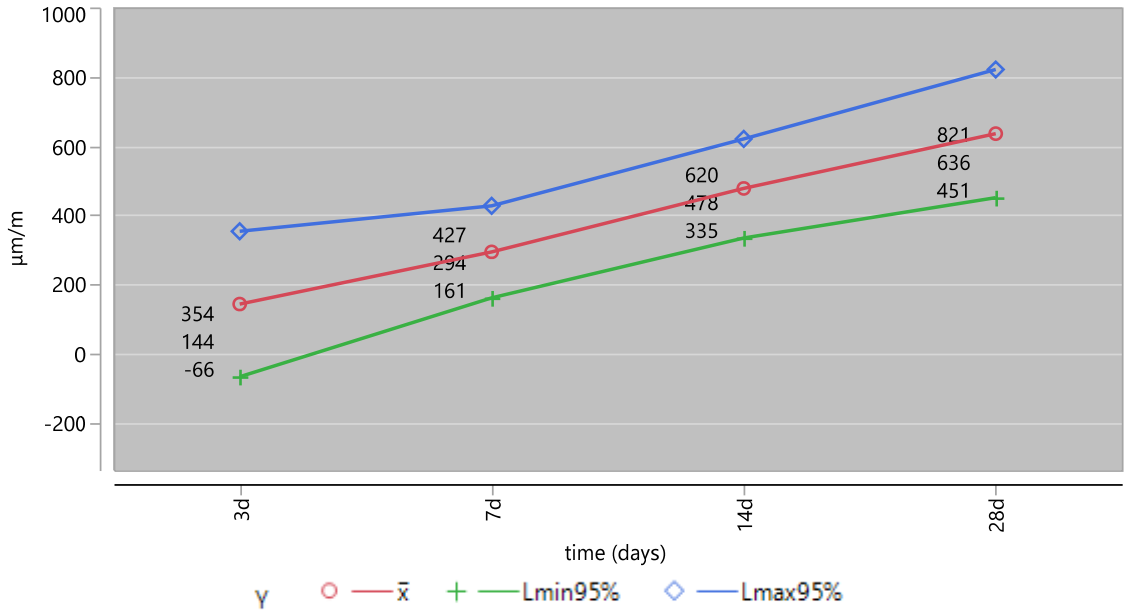
- Comparative curves for these two methods are presented here (for some 60 determinations per particle size bracket). The various dimensions defined by the participating laboratories were brought back to standard as per the R10 series by using a logarithmic interpolation. Results display a wider scattering between groups in the lower diameters. On the whole, tests results were satisfactory.
- The number of analyses carried out is summed up in tables at the end of the report.
- Alpine sieving is often used in the cement industry. Its main principle lies in separating particles by air depression through a sieve.
- For each particle size analysis method, the specific size criterion is related to the physical phenomenon involved. This criterion should be translated into an equivalent size, this particle size representing the same value of the specific size criterion than the particle being observed.

Granulometry - Eliminated Outliers
Confidence Level = 2%

Diam µm	Labo	Groupe de Labo	Méthode	Valeur
200	14	1 - European Pilots	Alpine	99.1
12.5	21	2 - French Laboratories	Laser	76.4
2	32	2 - French Laboratories	Laser	24.7
8	32	2 - French Laboratories	Laser	57.9
13	75	2 - French Laboratories	Laser	47.2
17	75	2 - French Laboratories	Laser	59.3
22	75	2 - French Laboratories	Laser	72.0
3.15	76	2 - French Laboratories	Laser	11.9
90	104	3 - European Laboratories	Alpine	99.5
5,75	136	3 - European Laboratories	Laser	32.2
6.61	136	3 - European Laboratories	Laser	34.6
7.59	136	3 - European Laboratories	Laser	37.2
10	136	3 - European Laboratories	Laser	42.9
11.48	136	3 - European Laboratories	Laser	46.1
13.18	136	3 - European Laboratories	Laser	49.5
15.14	136	3 - European Laboratories	Laser	53.2
19.95	136	3 - European Laboratories	Laser	61.5
15.13	139	3 - European Laboratories	Laser	92.8
17.37	139	3 - European Laboratories	Laser	92.9
2	141	3 - European Laboratories	Laser	2.5
3.15	141	3 - European Laboratories	Laser	4.3
4	141	3 - European Laboratories	Laser	6.9
5	141	3 - European Laboratories	Laser	11.5
6.3	141	3 - European Laboratories	Laser	19.7
8	141	3 - European Laboratories	Laser	32.1
80	157	3 - European Laboratories	Laser	98.8
90	157	3 - European Laboratories	Laser	98.8
100	157	3 - European Laboratories	Laser	98.8
125	157	3 - European Laboratories	Laser	98.8
160	157	3 - European Laboratories	Laser	98.8
200	157	3 - European Laboratories	Laser	98.8

8. SKRINKAGE IN AIR and SWELLING UNDER WATER

Skrinkage - Mean A.M.U



Skrinkage 3d – By Population A.M.U

Population	Method	Number of Results	x̄	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots		4	109	63	40	36.6	-18	235
2 - French Laboratories		12	127	23	37	28.7	47	208
3 - European Laboratories		4	127	88	55	43.5	-49	304

Skrinkage 3d - Eliminated Outliers
Confidence Level = 2%

N° Lab	Population	Method	Value
78	2 - French Laboratories		550

Skrinkage 7d - By Population A.M.U

Population	Method	Number of Results	x̄	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots		5	268	66	53	19.7	121	415
2 - French Laboratories		12	286	19	30	10.4	220	352
3 - European Laboratories		4	297	100	63	21.2	96	498

Skrinkage 7d - Eliminated Outliers
Confidence Level = 2%

N° Lab	Population	Method	Value
78	2 - French Laboratories		515

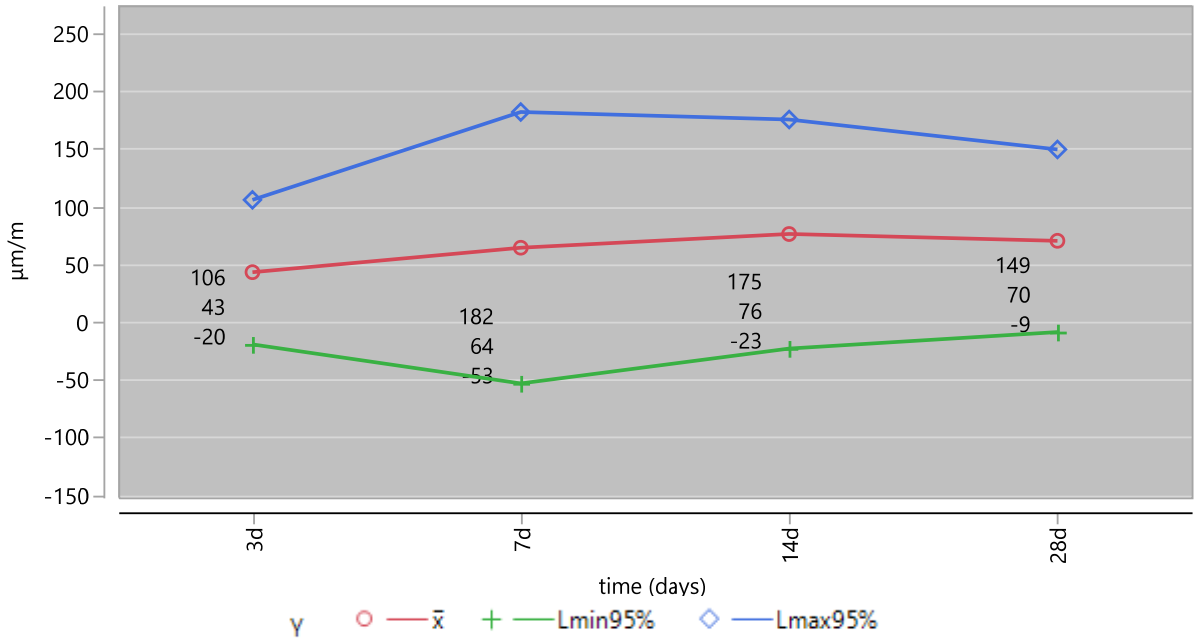
Skrinkage 14d - By Population A.M.U

Population	Method	Number of Results	x̄	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots		5	467	69	56	12.0	311	622
2 - French Laboratories		13	491	37	61	12.4	359	623
3 - European Laboratories		4	448	174	109	24.4	100	795

Skrinkage 28d - By Population A.M.U

Population	Method	Number of Results	x̄	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots		5	657	63	51	7.7	516	798
2 - French Laboratories		13	637	52	86	13.4	450	823
3 - European Laboratories		4	607	229	144	23.8	148	1066

Swelling – Mean A.M.U



Swelling 3d - By Population A.M.U

Population	Method	Number of Results	x̄	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots		2	13	20	2	17.1	-15	42
2 - French Laboratories		8	42	21	25	59.7	-17	101
3 - European Laboratories		2	77	180	20	26.0	-177	332

Swelling 7d - By Population A.M.U

Population	Method	Number of Results	x̄	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots		2	24	147	16	68.0	-184	232
2 - French Laboratories		8	55	33	39	71.8	-38	147
3 - European Laboratories		2	143	574	64	44.7	-669	954

Swelling 7d - Eliminated Outliers
Confidence Level = 2%

N° Lab	Population	Method	Value
150	3 - European Laboratories		142

Swelling 14d - By Population A.M.U

Population	Method	Number of Results	x̄	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots		2	23	265	29	129.0	-352	397
2 - French Laboratories		8	74	26	31	41.5	1	147
3 - European Laboratories		2	137	385	43	31.4	-408	682

Swelling 14d - Eliminated Outliers
Confidence Level = 2%

N° Lab	Population	Method	Value
150	3 - European Laboratories		342

Swelling 28d - By Population A.M.U

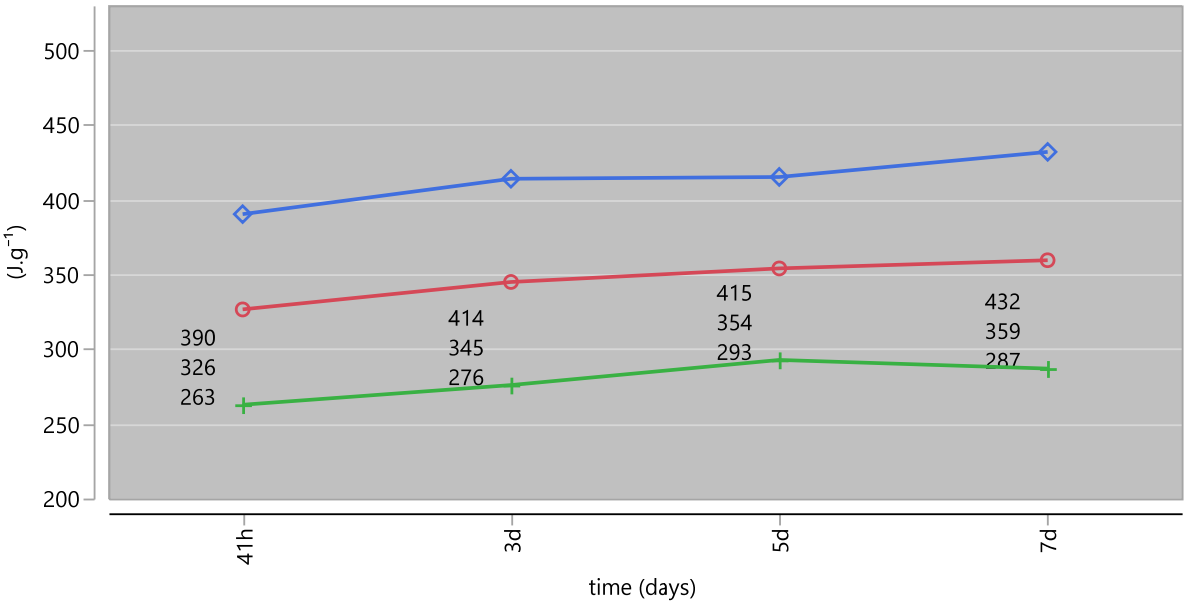
Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots		3	58	142	57	98.1	-187	304
2 - French Laboratories		8	75	27	32	42.8	-1	151
3 - European Laboratories		2	70	354	39	56.4	-430	570

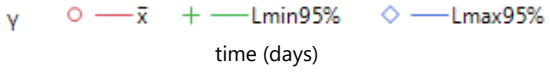
Swelling 28 d - Eliminated Outliers
Confidence Level = 2%

N° Lab	Population	Method	Value
150	3 - European Laboratories		973

- Dimensional variations such **as shrinkage in air and swelling under water** were carried out following French standard NF P 15-433. The values taken into account represent the mean values of the results observed on three specimens at 3, 7, 14 and 28 days, expressed in µm/m, and with the tests results rounded up to the nearest tens. Coefficients of variation are high. The results of every participant are presented in the figure opposite. The spindle shape represents the limits within which 95% of the values stand.

9. Heat of Hydration - Mean A.M.U





Heat of hydration 41h - By Population - Semi-adiabatic method

Population	Method	Number of Results	x̄	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots		11	336	12	18	5.4	296	376
2 - French Laboratories		11	331	12	17	5.2	292	369
3 - European Laboratories		13	326	14	24	7.3	274	378

Heat of hydration 41h - Eliminated Outliers
Confidence Level = 2%

N° Lab	Population	Method	Value
119	3 - European Laboratories		184

Heat of hydration 3j - By Population - Semi-adiabatic method

Population	Method	Number of Results	x̄	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots		6	365	24	23	6.2	307	423
2 - French Laboratories		9	340	18	23	6.7	287	393
3 - European Laboratories		11	346	24	35	10.2	268	424

Heat of hydration 3 j - Eliminated Outliers
Confidence Level = 2%

N° Lab	Population	Method	Value
119	3 - European Laboratories		258

Heat of hydration 5j - By Population - Semi-adiabatic method

Population	Method	Number of Results	x̄	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots		6	372	28	27	7.2	303	441
2 - French Laboratories		9	345	19	24	7.1	289	401
3 - European Laboratories		10	351	24	33	9.5	276	426

Heat of hydration7j – By population - Solution method

Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots		2	**383**	232	26	6.7	**56**	**711**
3 - European Laboratories		8	**353**	27	32	9.0	**278**	**429**

Maximale Flux – By population

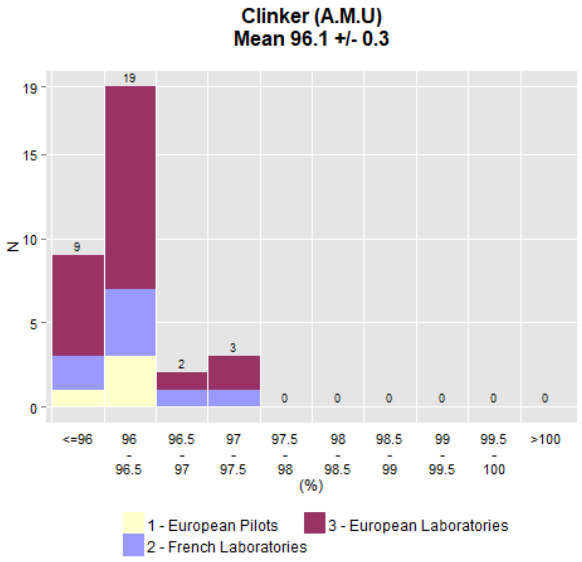
Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots		1	**28.5**					
2 - French Laboratories		7	**30.1**	2.3	2.5	8.4	23.9	36.3
3 - European Laboratories		7	**28.9**	4.2	4.6	15.9	17.6	40.1

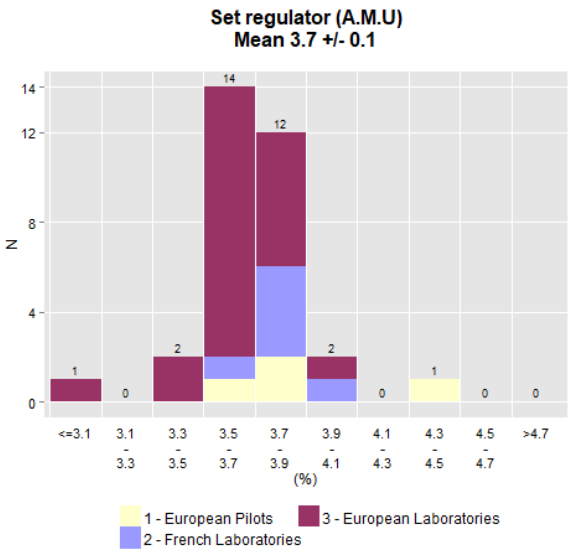
Age at maximale flux – By population

Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots		1	**8.0**					
2 - French Laboratories		7	**9.1**	0.8	0.9	9.8	6.9	11.3
3 - European Laboratories		7	**8.6**	0.3	0.3	3.9	7.7	9.4

- 27 laboratories carried out **the heat of hydration using the semi-adiabatic method** (described in European standard **EN 196-9**) and **10 the dissolution method** (**EN 196-8**). Hydration heat calculations were carried out at 41 hours, 3, 5, and 7 days. The standard deviation reproducibility at 41 hours specified in European standard **EN 196-9,** is 15 $J.g^{-1}$. Comparison between the two methods used for hydration heat determination is not possible, as there are too few results available for the dissolution method. Deviations between laboratories may be due to imperfectly controlled heat losses just before starting measures, or as always, to the calibration of the calorimeter, the temperature in the testing room, or air circulation speed around the apparatus, this last a very influential factor.

10- Mineralogy





Clinker - By population Group & Method

Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots		4	96.1	0.6	0.4	0.4	94.9	97.2
2 - French Laboratories		8	96.2	0.7	0.8	0.8	94.3	98.0
3 - European Laboratories		20	96.1	0.4	0.9	0.9	94.3	97.9

Clinker - Eliminated Outliers
Confidence Level = 2%

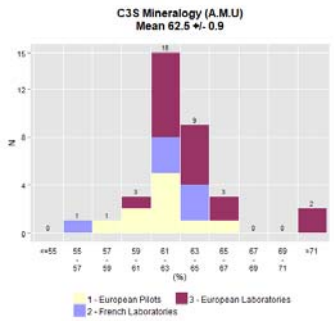
N° Lab	Population	Method	Value
128	3 - European Laboratories		93.1

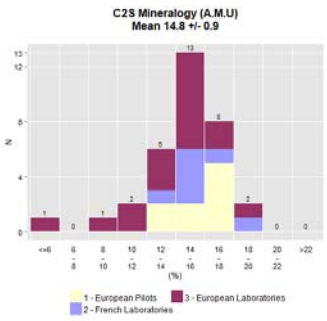
Set Regulator - By population Group & Method

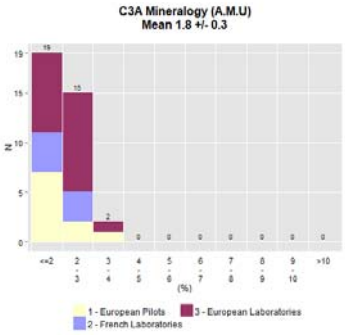
Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots		3	3.8	0.1	0.1	1.5	3.5	4.0
2 - French Laboratories		6	3.8	0.1	0.1	3.5	3.5	4.2
3 - European Laboratories		21	3.7	0.1	0.1	3.7	3.4	4.0

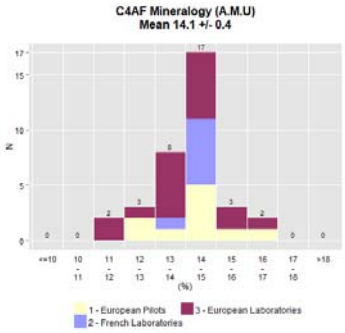
Set Regulator - Eliminated Outliers
Confidence Level = 2%

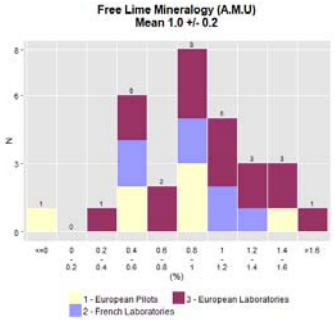
N° Lab	Population	Method	Value
10	1 – European Pilots		4.5
120	3 - European Laboratories		2.6

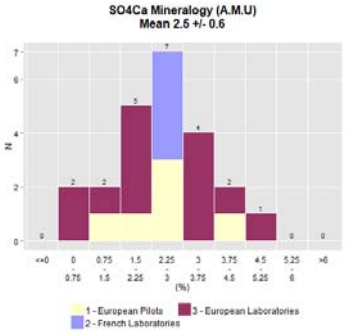












Mineralogy C_3S - By population Group & Method

Population	Method	Number of Results	$\bar{x}$	ε	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots		10	62.1	1.5	2.1	3.3	57.4	66.7
2 - French Laboratories		7	61.9	2.4	2.6	4.3	55.5	68.4
3 - European Laboratories		15	63.0	1.1	2.0	3.1	58.8	67.2

Mineralogy C_3S - Eliminated Outliers
Confidence Level = 2%

N° Lab	Population	Method	Value
135	3 - European Laboratories		73.1
141	3 - European Laboratories		72.2

Mineralogy C_2S - By population Group & Method

Population	Method	Number of Results	$\bar{x}$	ε	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots		9	15.3	1.3	1.7	10.9	11.4	19.2
2 - French Laboratories		7	15.6	1.5	1.6	10.3	11.7	19.5
3 - European Laboratories		16	14.2	1.2	2.3	15.9	9.4	19.0

Mineralogy C_3S - Eliminated Outliers
Confidence Level = 2%

N° Lab	Population	Method	Value
135	3 - European Laboratories		2.5

Mineralogy C_3A - By population Group & Method

Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots		10	1.6	0.7	1.0	58.9	-0.5	3.8
2 - French Laboratories		7	1.9	0.6	0.6	33.5	0.3	3.4
3 - European Laboratories		19	1.9	0.4	0.9	45.4	0.1	3.7

Mineralogy C_4AF - By population Group & Method

Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots		10	14.3	0.9	1.2	8.4	11.6	17.0
2 - French Laboratories		7	14.4	0.4	0.4	2.6	13.5	15.3
3 - European Laboratories		18	13.9	0.6	1.2	8.4	11.4	16.3

Mineralogy Free lime - By population Group & Method

Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots		7	0.7	0.4	0.5	63.8	-0.4	1.9
2 - French Laboratories		7	1.0	0.3	0.3	34.8	0.1	1.8
3 - European Laboratories		16	1.0	0.2	0.4	37.7	0.2	1.9

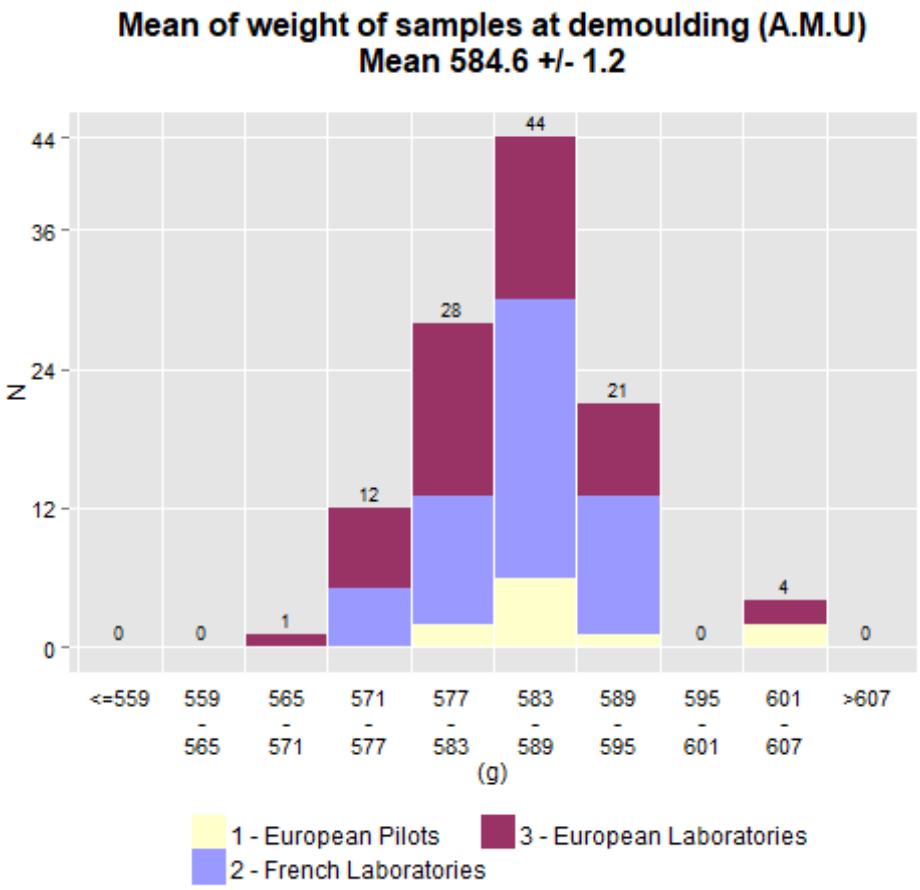
Mineralogy SO_4Ca - By population Group & Method

Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots		6	2.5	1.2	1.2	45.8	-0.4	5.5
2 - French Laboratories		4	2.8	0.4	0.3	9.5	1.9	3.6
3 - European Laboratories		13	2.5	0.9	1.4	57.8	-0.6	5.6

- Clinker set control agent and minor additional constituents material determination were realised following Technical Report CEN/TR 196-4 on quantitative determination of constituents. Results were very homogenous.

- 49 laboratories participated in the mineralogical tests. Mineral composition of cement may be determined using the chemical analysis results and the Bogue equations but using X-ray diffraction analysis is more reliable. Results were relatively homogenous.

11. Mechanical Tests



Mean of mass on demoulding 4x4x16 - By population Group & Method

Population	Method	Number of Results	$\bar{x}$	ε	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots		9	**584.8**	2.6	3.4	0.6	**577.1**	**592.6**
2 - French Laboratories		51	**585.3**	1.4	5.0	0.9	**575.3**	**595.3**
3 - European Laboratories		44	**583.7**	1.6	5.2	0.9	**573.1**	**594.3**

Mean of mass on demoulding 4x4x16 - Eliminated Outliers
Confidence Level = 2%

N° Lab	Population	Method	Value
2	1 - European Pilots		**603.0**
2a	1 - European Pilots		**604.1**
75	2 - French Laboratories		**572.3**
113	3 - European Laboratories		**601.2**
136	3 - European Laboratories		**566.5**
138	3 - European Laboratories		**601.8**

Bending 1 day - By population Group & Method

Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots		7	4.0	0.3	0.3	7.3	3.3	4.7
2 - French Laboratories		16	4.4	0.2	0.4	9.0	3.6	5.3
3 - European Laboratories		31	4.4	0.1	0.3	7.9	3.7	5.1

Bending 1 day - Eliminated Outliers
Confidence Level = 2%

N° Lab	Population	Method	Value
82	2 - French Laboratories		5.5

Bending 2 days - By population Group & Method

Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots		7	5.8	0.2	0.2	3.5	5.3	6.3
2 - French Laboratories		15	5.8	0.2	0.4	7.3	4.9	6.7
3 - European Laboratories		32	5.9	0.1	0.3	5.7	5.2	6.6

Bending 2 days - Eliminated Outliers
Confidence Level = 2%

N° Lab	Population	Method	Value
79	2 - French Laboratories		4.7
122	3 - European Laboratories		6.8

Bending 7 days - By population Group & Method

Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots		7	7.5	0.2	0.2	2.4	7.0	7.9
2 - French Laboratories		16	7.5	0.3	0.6	7.6	6.3	8.7
3 - European Laboratories		32	7.5	0.2	0.5	6.0	6.6	8.5

Bending 7 days - Eliminated Outliers
Confidence Level = 2%

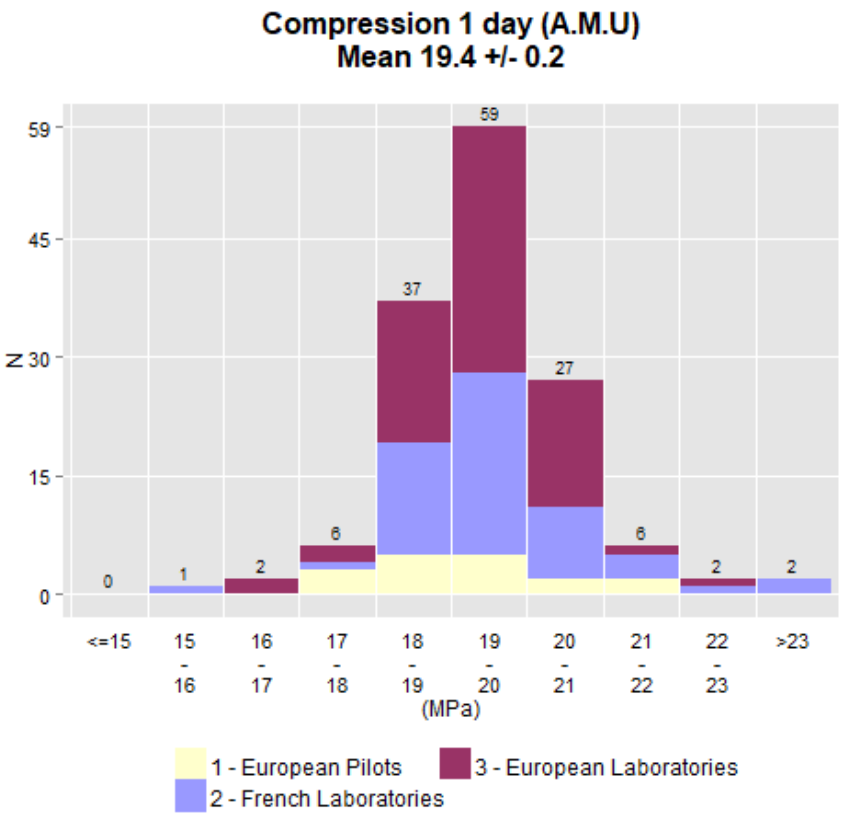
N° Lab	Population	Method	Value
75	2 - French Laboratories		5.9

Bending 28 days - By population Group & Method

Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots		7	8.0	0.3	0.3	4.2	7.2	8.8
2 - French Laboratories		15	8.2	0.2	0.3	3.6	7.6	8.9
3 - European Laboratories		33	8.4	0.1	0.4	5.0	7.5	9.2

Bending 28 days - Eliminated Outliers
Confidence Level = 2%

N° Lab	Population	Method	Value
75	2 - French Laboratories		7.2
81	2 - French Laboratories		9.9



Compressive strength 1 day - By population Group & Method

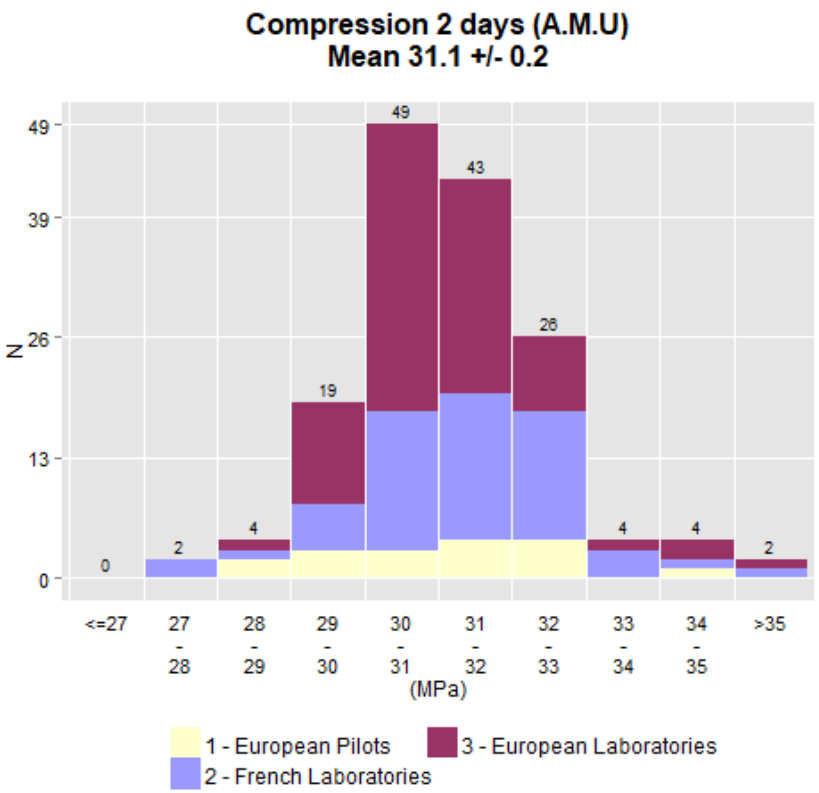
Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots	A.M.U.	17	19.2	0.6	1.2	6.0	16.8	21.7
2 - French Laboratories	A.M.U.	50	19.5	0.2	0.8	4.3	17.8	21.2
3 - European Laboratories	A.M.U.	67	19.4	0.2	0.8	4.1	17.8	21.0

Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European pilots	A	15	19.3	0.6	1.2	6.1	16.8	21.8
1 - European pilots	D	2	18.5	7.9	0.9	4.8	7.2	29.7
2 - French Laboratories	A	48	19.5	0.2	0.8	4.3	17.8	21.2
2 - French Laboratories	D	2	19.2	12.9	1.4	7.5	0.9	37.5
3 - European Laboratories	A	46	19.4	0.2	0.8	4.1	17.8	21.0
3 - European Laboratories	D	21	19.3	0.4	0.8	4.2	17.6	21.0

Compressive strength 1 day - Eliminated Outliers
Confidence Level = 2%

N° Lab	Population	Method	Value
55	2 - French Laboratories	A	16.0
56	2 - French Laboratories	A	23.5
78	2 - French Laboratories	A	22.9
82	2 - French Laboratories	A	23.7
136	3 - European Laboratories	A	16.7
136	3 - European Laboratories	D	16.7
150	3 - European Laboratories	D	21.9
152	3 - European Laboratories	D	22.4

- The mean for compressive strength at 1 day between the three populations are excellent.



Compressive strength 2 days - By population Group & Method

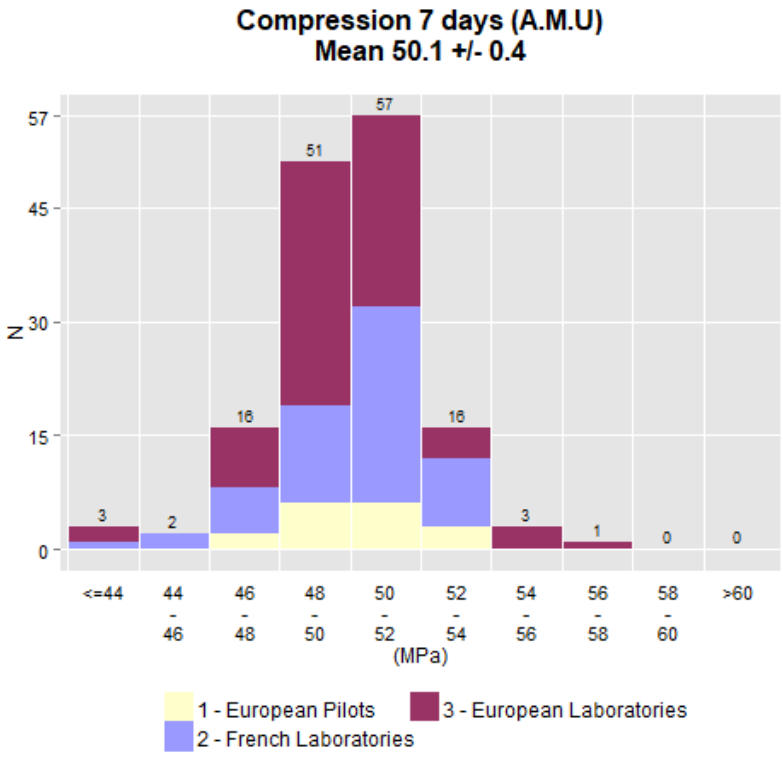
Population	Method	Number of Results	$\bar{x}$	ε	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots	A.M.U.	17	**31.0**	0.8	1.5	4.9	**27.8**	**34.2**
2 - French Laboratories	A.M.U.	55	**31.4**	0.3	1.2	3.8	**29.0**	**33.8**
3 - European Laboratories	A.M.U.	75	**30.9**	0.2	0.9	2.9	**29.1**	**32.7**

Population	Method	Number of Results	$\bar{x}$	ε	S_R	CV (%)	Lm95%	LM95%
1 - European pilots	A	15	**31.1**	0.9	1.6	5.2	**27.6**	**34.5**
1 - European pilots	D	2	**30.7**	5.7	0.6	2.1	**22.6**	**38.8**
2 - French Laboratories	A	53	**31.4**	0.3	1.2	3.8	**29.0**	**33.8**
2 - French Laboratories	D	2	**31.1**	12.4	1.4	4.4	**13.6**	**48.6**
3 - European Laboratories	A	51	**30.9**	0.2	0.9	2.8	**29.2**	**32.6**
3 - European Laboratories	D	24	**30.8**	0.4	1.0	3.1	**28.8**	**32.8**

Compressive strength 2 days - Eliminated Outliers
Confidence Level = 2%

N° Lab	Population	Method	Value
56	2 - French Laboratories	A	**35.3**
73a	2 - French Laboratories	A	**27.9**
79	2 - French Laboratories	A	**27.3**
126	3 - European Laboratories	A	**34.5**
126a	3 - European Laboratories	A	**35.4**
152	3 - European Laboratories	D	**34.1**

- Homogeneity means for compressive strength to two days, whatever the population and the methods used.



Compressive strength 7 days - By population Group & Method

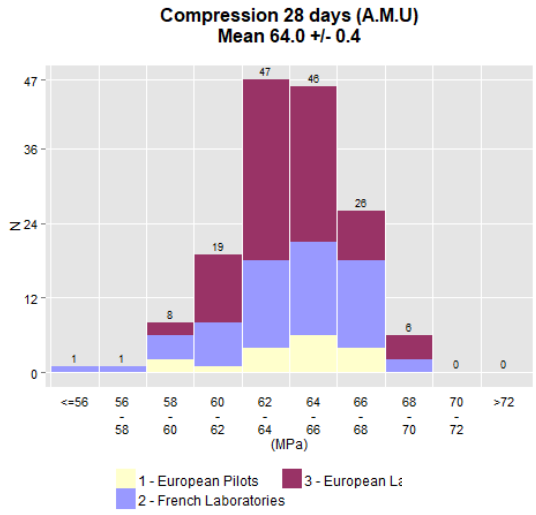
Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots	A.M.U.	17	**50.2**	0.9	1.8	3.6	**46.4**	**54.1**
2 - French Laboratories	A.M.U.	55	**50.4**	0.5	1.8	3.6	**46.7**	**54.1**
3 - European Laboratories	A.M.U.	72	**49.9**	0.4	1.8	3.6	**46.3**	**53.5**

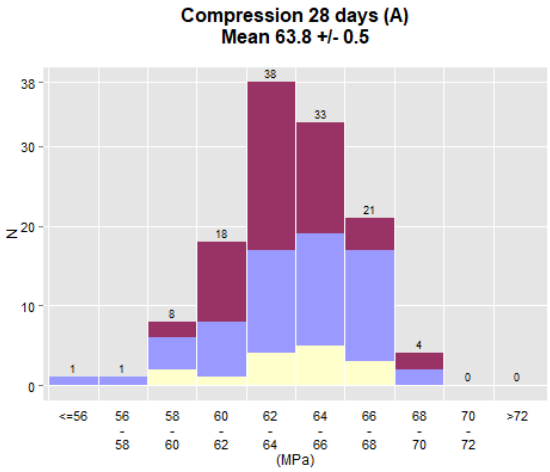
Population	Method	Number of Results	$\bar{x}$	Ɛ	S_R	CV (%)	Lm95%	LM95%
1 - European pilots	A	15	**50.2**	1.1	1.9	3.9	**46.0**	**54.4**
1 - European pilots	D	2	**50.5**	2.5	0.3	0.6	**46.9**	**54.1**
2 - French Laboratories	A	53	**50.4**	0.5	1.8	3.7	**46.6**	**54.1**
2 - French Laboratories	D	2	**51.4**	13.1	1.5	2.8	**32.8**	**69.9**
3 - European Laboratories	A	48	**49.5**	0.5	1.6	3.1	**46.4**	**52.6**
3 - European Laboratories	D	24	**50.8**	0.8	2.0	3.9	**46.7**	**54.9**

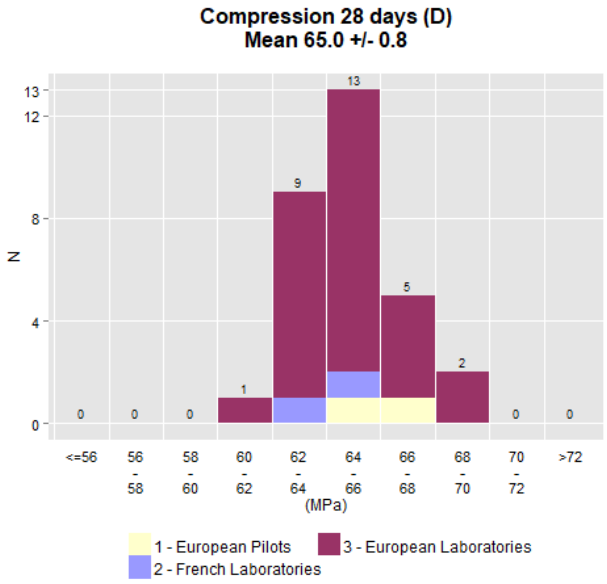
Compressive strength 7 ays - Eliminated Outliers
Confidence Level = 2%

N° Lab	Population	Method	Value
22a	2 - French Laboratories	A	**43.6**
82	2 - French Laboratories	A	**44.1**
126	3 - European Laboratories	A	**43.8**
126a	3 - European Laboratories	A	**56.5**
155	3 - European Laboratories	A	**38.6**

- Homogeneous results for compressive strength to seven days whatever the population and the methods used.







Compressive strength 28 days - By population Group & Method

Population	Method	Number of Results	$\bar{x}$	ε	S_R	CV (%)	Lm95%	LM95%
1 - European Pilots	A.M.U.	17	**63.9**	1.2	2.3	3.6	**59.1**	**68.7**
2 - French Laboratories	A.M.U.	56	**64.3**	0.7	2.5	3.9	**59.3**	**69.3**
3 - European Laboratories	A.M.U.	78	**63.9**	0.5	2.1	3.2	**59.8**	**68.0**

Population	Method	Number of Results	$\bar{x}$	ε	S_R	CV (%)	Lm95%	LM95%
1 - European pilots	A	15	**63.7**	1.3	2.3	3.7	**58.7**	**68.7**
1 - European pilots	D	2	**65.4**	10.7	1.2	1.8	**50.3**	**80.6**
2 - French Laboratories	A	54	**64.3**	0.7	2.5	3.9	**59.2**	**69.3**
2 - French Laboratories	D	2	**64.6**	9.7	1.1	1.7	**50.9**	**78.4**
3 - European Laboratories	A	52	**63.4**	0.5	2.0	3.1	**59.4**	**67.4**
3 - European Laboratories	D	26	**64.9**	0.8	1.9	2.9	**61.0**	**68.9**

Compressive strength 28 days - Eliminated Outliers
Confidence Level = 2%

N° Lab	Population	Method	Value
73a	2 - French Laboratories	A	**56.1**
82	2 - French Laboratories	A	**55.6**
126a	3 - European Laboratories	A	**69.4**

Remarks on compression tests at 28 days

- The biggest mean deviation between compressive strength values at 28 days is between the French laboratories and European pilots and the European laboratories. It is **0,4 MPa**, whatever the standard followed, or the type of sand used. This deviation for a **CEM I 52,5 N** is an good result.
- Compressive strength tests results are homogeneous, the maximum difference for mean values at 28 days is **2,0 MPa** (between European pilots using national sand and EN 196-1 standard and European laboratories using their CEN AFNOR sand and the EN 196-1 standard). This small difference can be explained on the sands used.
- Several factors are involved in compressive strength results, the main ones being the procedure for making the specimen (mixing, vibrating technique, curing), the operating procedures and the type of sand.
- The ensuing differences in values found at 28 days call for the following comments:
  - The difference of **0,3 MPa** between European pilot laboratories and European laboratories using the same sand and following the same standard (EN 196-1) is an excellent result.
  - The difference of **0,9 MPa** between French laboratories and European laboratories using the same sand and the same standard (EN 196-1) is a satisfactory result for a **CEM I 52,5 N**.
  - This year, we note a difference of **1,5 MPa** between the European laboratories following the same European standard EN 196-1 but with various types of CEN sands. It is a good result.

Coefficients of variation (%) for the physical and the mechanical tests

	Specific gravity	Specific surface	Normal consistency	Initial setting time	Skrinkage at 28 days	Heat of Hydration 5	Mass on Demoulding	C 1 Day	C 2 Days	C 7 Days	C28 Days
1988 CPA HPR	0,7	1,8	2,3	15,6	14,5	7,0	1,0	8,4	5,8	4,9	3,9
1989 CPJ 45	0,9	2,7	2,2	11,0	14,6	6,0	0,9	10,5	5,6	4,5	3,9
1990 CPA 55	0,5	2,2	1,7	16,1	10,0	7,6	0,8	6,9	5,0	3,9	3,8
1991 CPJ 55 R	0,6	2,2	1,9	11,5	8,5	9,6	1,0	9,5	4,8	4,2	4,1
1992 CPA 55	0,6	2,3	2,0	11,7	11,5	10,0	1,1	8,7	4,6	4,3	4,1
1993 CPJ 45	0,8	2,4	2,8	13,8	10,0	11,7	1,0	9,6	5,0	4,7	4,5
1994 CPA HPR	0,8	2,3	2,7	14,0	12,7	9,5	1,0	6,6	4,7	4,4	4,4
1995 CPJ-CEM II/A 42,5 R	0,8	2,6	2,0	13,1	12,8	8,9	1,1	6,3	5,3	4,6	5,0
1996 CPA-CEM I 42,5 R	0,8	2,6	2,1	15,1	14,6	8,4	1,1	5,9	4,2	4,6	4,4
1997 CPJ-CEM II/A 32,5 R	0,8	3,4	3,3	14,5	8,4	7,9	1,2	8,7	5,6	6,1	6,1
1998 CPA-CEM I 52,5 R	0,8	2,3	2,7	14,4	11,5	11,1	1,1	6,1	5,2	4,5	4,7
1999 CPJ-CEM II/A 52,5 R	0,9	2,3	2,3	13,2	14,2	6,3	1,2	8,9	4,6	4,9	4,7
2000 CPA-CEM I/A 52,5	0,9	2,9	2,1	10,8	17,4	10,2	1,0	7,0	4,9	4,6	4,1
2001 CEM III/A 42,5	0,8	2,9	2,4	10,0	18,3	5,5	1,0	10,1	6,6	4,7	3,7
2002 CEM I 52,5 R	0,9	2,8	2,2	10,2	17,5	10,1	1,1	5,7	4,0	3,6	3,7
2003 CEM II/B-M 32,5 R	1,0	3,8	3,7	6,7	12,6	5,4	1,0	14,9	6,4	4,1	3,7
2004 CEM I 52,5 N	0,7	2,6	2,7	12,7	17,8	5,9	1,2	5,7	4,3	4,3	4,4
2005 CEM II/A-LL 32,5 R	0,8	2,4	2,6	12,2	17,8	5,5	1,1	8,6	5,5	4,8	4,6
2006 CEM I 52,5 R	0,8	2,7	2,1	11,2	10,8	5,0	1,1	5,8	4,1	3,8	3,7
2007 CEM II/B-L 32,5 R	0,8	2,5	2,2	11,4	11,6	7,6	1,1	10,2	6,3	5,5	5,7
2008 CEM I 52,5 N	0,7	2,8	1,9	10,7	16,0	7,8	1,3	6,7	5,1	4,5	4,4
2009 CEM II/B-V 32,5 R	0,9	3,1	2,5	12,5	12,1	7,6	0,9	10,2	7,9	4,3	3,8
2010 CEM I 52,5 N	0,6	3,1	1,8	13,4	14,1	8,1	1,0	5,9	4,8	4,2	3,7
2011 CEM II/B-M 32,5 R	0,7	2,4	2,1	11,9	14,9	8,1	1,2	8,5	4,9	4,0	4,0
2012 CEM I 52,5 N	0,6	2,4	2,0	10,9	14,1	8,1	1,3	4,9	4,1	4,1	3,8
2013 CEM II/A-LL 32,5 R	0,7	3,0	2,0	10,2	18,5	6,7	1,0	7,4	5,0	4,1	3,9
2014 CEM I 52,5 R	0,7	2,5	2,0	11,6	18,5	9,1	1,1	4,7	3,6	3,6	3,5
2015 CEM II/B-M 32,5 R	0,6	2,8	1,8	10,4	12,2	9,4	0,9	9,0	4,8	3,7	3,6
2016 CEM I 52,5 N	0,6	2,8	2,5	11,3	10,1	10,5	1,1	6,3	4,0	4,1	3,9
2017 CEM II/B-LL 32,5 R	0,8	3,6	2,0	10,2	12,0	6,6	1,2	6,0	5,1	4,7	5,0
2018 CEM I 52,5N	0,6	3,7	2,1	10,3	11,0	9,0	1,0	5.4	4,1	4,2	3,7
2019 CEM II/B-LL 32,5R	0,6	2,5	1,8	6,9	10,5	7,8	1,0	9,2	5,5	4,7	4,0
2020 CEM I 52,5 N	1,0	3,1	3,1	10,3	14,0	8,4	0,9	4,4	3,6	3,6	3,5

12. Conclusion

The 2020 round-robin test collected **134 participants**, from 21 **countries**. The cement used this year was a **CEM I 52,5 N**. This year, due to the pandemic, only laboratories located in the European zone participated in this testing campaign.

The results call for the following comments:

- **Chemical analyses** brought forth satisfactory results. Recurring high dispersions due to low contents concern chiefly free CaO, insoluble residues and Na_2O. We note that **76 %** of the tests were done using X-ray fluorescence analysis. This figure is stable compared to previous years. You will find the comments on the chemical analysis results **p.23**.

  - **The Physical tests** this year showed a slight dispersion due mainly to changes in the statistical population (differentiation between French and European laboratories), this is the case for :

    - the specific gravity, as shown in the histogram with a peak of values below 3,15 g/cm^3.

    - and the normal consistency with a coefficient of variation of 3.1%.

- **Mechanical tests** showed the differences in means are satisfactory for a cement of this type, namely:

  - a difference of 0.4 MPa in mean (A.M.U.) in compression at 28 days, between the French laboratories and the European pilot laboratories and European laboratories, excellent, for an EMC I 52.5 N (64.3 MPa and 63.9 MPa).

  - an extreme difference in compression at 28 days of 2.0 MPa, between the European pilot laboratories using their national sand and the EN 196-1 standard and the European laboratories using CEN AFNOR sand and the EN 196-1 standard). Differences in sand can explain this difference at 28 days.

  - finally, a difference of 1.5 MPa between the European laboratories using the same standard (EN 196-1) and different CEN sands. This is a good result for cement of this nature.

- The results obtained by the laboratories for this 2020 campaign are a little more dispersed for the physical tests. The main reason for this is the differentiation of the usual population of European laboratories, which has been split into French and European laboratories. We insist again on the fact that when standard operating procedures exists, laboratories should undertake to follow them.

- Reports are emailed directly with pdf format attachment. Your outliers and/or suspect values will be sent in a table along with the General Report. You will then check possible defective values with your laboratory number. In the report, outlier values are mentioned after each test.

- I am glad to have the opportunity to thank the whole of the participating laboratories for their collaboration in efficiently following our instructions. We would like the information on laboratory equipment used as well as the various materials proposed (carrier fluid, sand, etc.) to be systematically informed.

- We thank those laboratories that have sent us comments aiming to improve the Excel sheet and we invite other participants to share their reviews, comments and suggestions in this same spirit of overall streamlining and clarification.

Annexes

Labs	Loss on ignition (%)	SiO2 (%)	Al2O3 (%)	Fe2O3 (%)	CaO (%)	MgO (%)	MnO (%)	SO3 (%)	Free lime (%)	Insoluble residue (%)	Na2O (%)	K2O (%)	TiO2 (%)	Chloride (%)	P2O5 (%)	SrO (%)	CO2 (%)	S-- (%)	Cr6+ (%)
1	K 0.94	X 21.41	X 3.58	X 4.89	X 64.40	X 1.27	X 0.13	K 2.24	C 0.97	K 0.23	X 0.27	X 0.51	X 0.12	K 0.006	X 0.28	X 0.09	N 0.22	K 0.008	0.000015
1								X 2.34						P 0.000					
2	K 0.81	K 21.32	K 3.47	K 4.64	K 64.32	K 1.35	X 0.14	K 2.40	G 1.21	K 0.31	K 0.27	K 0.44	X 0.14	M 0.028	X 0.26	X 0.09	N 0.64	N 0.020	K 0.000093
2		X 21.33	X 3.50	X 4.85	X 64.30	X 1.28		X 2.45			X 0.22	X 0.50		X 0.040					
2a	K 0.86	K 21.26	K 3.49	K 4.89	K 64.34	K 1.20	X 0.15	K 2.27	G 1.18	K 0.27	K 0.29	K 0.44	X 0.14	M 0.019	X 0.27	X 0.09	N 0.61	N 0.010	K 0.000071
2a		X 21.38	X 3.52	X 4.85	X 64.17	X 1.28		X 2.45			X 0.22	X 0.52		X 0.020					
3	K 0.76	K 21.47	K 3.49	K 4.95	K 64.61	K 1.27	X 0.12	K 2.30	C 1.18	K 0.20	K 0.21	K 0.51	X 0.13	M 0.008	X 0.27	X 0.09			
4	K 0.88	X 21.21	X 3.52	X 4.93	X 64.35	X 1.27	X 0.08	N 2.32	G 1.30	K 0.41	X 0.21	X 0.50	X 0.13	P 0.010	X 0.27		0.27	P 0.010	0.000106
5a	N 1.05	X 21.17	X 3.38	X 4.90	X 64.26	X 1.29	X 0.15	X 2.39	G 1.05	K 0.34	X 0.23	X 0.53	X 0.13	M 0.006	X 0.26	X 0.08	0.52		0.000002
5a		X 21.04	X 3.37	X 4.88	X 64.18	X 1.29	X 0.15	X 2.33		K 0.34	X 0.22	X 0.53	X 0.13		X 0.26	X 0.09			
6	K 0.90	K 21.35	K 3.47	K 5.00	K 64.54	K 1.33		K 2.37	G 0.98	K 0.24	K 0.20	K 0.51	X 0.13	X 0.021	X 0.27	X 0.09			
6		X 21.29	X 3.54	X 5.01	X 64.45	X 1.27		X 2.40		K 0.29	X 0.21	X 0.51							
7	D 0.92	X 21.55	X 3.50	X 4.85	X 64.22	X 1.21	X 0.14	X 2.31	C 1.16	K 0.23	X 0.23	X 0.49	X 0.13	P 0.008	X 0.27	X 0.09	N 0.37	P 0.00	
7		X 21.35	X 3.56	X 4.83	X 64.06	X 1.23	X 0.14	X 2.30	C 1.15	K 0.28	X 0.23	X 0.51	X 0.13		X 0.27	X 0.09			
7								N 2.31			M 0.29	M 0.56							
8	K 0.94	K 20.33	K 3.43	K 4.93	K 64.12	K 1.25		K 2.29		K 0.18	K 0.19	K 0.50		M 0.007			0.67		
8	K 0.84			N 4.84				K 2.32		K 0.19				K 0.007					
9	D 0.94	X 21.21	X 3.38	X 4.84	X 64.16	X 1.19	X 0.13	K 2.24	G 0.80	K 0.18	X 0.19	X 0.51	X 0.13	P 0.007	X 0.28	X 0.09	0.36	0.030	0.000080
9								X 2.29						X 0.007					
10	K 0.79	X 21.16	X 3.38	X 4.86	X 64.43	X 1.24	X 0.13	K 2.30	G 1.28	K 0.25	X 0.17	X 0.53	X 0.13	P 0.008	X 0.26	X 0.09		0.000	0.000028
10	K 0.80	X 21.18	X 3.39	X 4.88	X 64.48	X 1.24	X 0.13	K 2.28		K 0.26	X 0.18	X 0.54	X 0.13		X 0.26	X 0.09			
10								X 2.32											
10								X 2.34											
10								N 2.34											
11	K 1.07	X 21.13	X 3.34	X 4.72	X 64.81	X 1.21	X 0.13	K 2.30	C 1.05	K 0.23	X 0.19	X 0.50	X 0.14	P 0.007	X 0.26	X 0.08	0.93	K 0.017	0.000026
11	K 1.04	X 21.18	X 3.34	X 4.71	X 65.00	X 1.22	X 0.13	K 2.33	C 1.03	K 0.18	X 0.19	X 0.51	X 0.14		X 0.26	X 0.09			
11	N 1.05																		
12	K 0.83	X 21.66	X 3.51	X 4.90	X 65.10	X 1.28	X 0.14	X 2.38		K 0.24	K 0.24	K 0.51	X 0.14	M .	X 0.26		N 0.34	K 0.020	K 0.000051
13	K 0.89	X 21.30	X 3.47	X 4.96	X 64.96	X 1.26	X 0.13	K 1.71	G 1.47	K 0.23	X 0.17	X 0.48	X 0.14	P 0.019	X 0.27	X 0.09			.
13	K 0.87	X 21.27	X 3.44	X 4.96	X 65.00	X 1.25	X 0.13	K 1.85					X 0.13	X 0.005	X 0.27	X 0.09			
13								X 2.14											
14	N 1.02	X 21.20	X 3.45	X 4.77	X 63.77	X 1.34	X 0.14	K 2.00			X 0.26	X 0.50	X 0.14	M 0.000	X 0.28	X 0.08			
14		X 21.31	X 3.50	X 4.77	X 63.78	X 1.35	X 0.14	K 1.87			X 0.26	X 0.51	X 0.14	P 0.000	X 0.28	X 0.08			
14								X 2.28											
14								X 2.31											
15	K 0.92	K 21.34	K 3.50	K 5.02	K 64.50	K 1.24	X 0.13	K 2.36	G 1.36	K 0.26	M 0.22	M 0.50	X 0.15	P 0.008	X 0.26	X 0.08		0.005	0.000105
15	K 0.94	K 21.23	K 3.45	K 5.00	K 64.38	K 1.24	X 0.13	K 2.31		K 0.30			X 0.16		X 0.26	X 0.08			
20	K 0.82	X 21.47	X 3.80	X 4.99	X 64.59	X 1.22		X 2.44	N 1.37		X 0.19	X 0.47	X 0.15	X 0.011	X 0.26				
20	K 0.76	X 21.51	X 3.81	X 5.01	X 64.46	X 1.21		X 2.44			X 0.17	X 0.47	X 0.15		X 0.26				
21	K 0.93	X 21.33	X 3.35	X 4.92	X 64.61	X 1.33	X 0.15	X 2.21	G 1.36	K 0.37	X 0.18	X 0.78	X 0.14	P 0.001	X 0.27	X 0.09		P 0.004	
22	K 1.09	X 21.19	X 3.57	X 4.96	X 64.70	X 1.29	X 0.13	X 2.20	G 1.38	K 0.27	X 0.14	X 0.48	X 0.14	M 0.002	X 0.27			P 0.003	N 0.000001
22								N 2.48											
23	K 0.91	X 21.22	X 3.56	X 5.05	X 64.62	X 1.17	X 0.16	K 2.22	G 1.19	K 0.30	X 0.21	X 0.52	X 0.17	P 0.010	X 0.27			P 0.000	N 0.000005
23								X 2.25											
24	K 1.01	X 21.31	X 3.68	X 4.93	X 64.59	X 1.18	X 0.15	K 2.44	B 1.24	K 1.15	X 0.25	X 0.52	X 0.16	P 0.018	X 0.29			P 0.000	K 0.000038
24								X 2.27											
25	K 0.86	X 21.19	X 3.46	X 4.85	X 64.49	X 1.27		K 2.27	C 1.20	K 0.53	X 0.22	X 0.50	X 0.13	P 0.011	X 0.27		0.49	P 0.000	0.000174
25								X 2.25											
26	K 0.89	X 21.24	X 3.63	X 4.78	X 64.13	X 1.14	X 0.04	X 2.32	C 1.42	K 0.22	X 0.18	X 0.50	X 0.17	K 0.007	X 0.23			P 0.100	K 0.000019
26	K 0.92	X 21.20	X 3.63	X 4.78	X 64.29	X 1.13	X 0.04	X 2.33	C 1.35		X 0.18	X 0.50	X 0.17	P 0.007	X 0.23				
27	K 0.83	X 21.34	X 3.53	X 4.90	X 64.39	X 1.27		X 2.30	C 1.40	K 0.29	X 0.15	X 0.52	X 0.13	P 0.000	X 0.27				0.000084
27	K 0.86	X 21.25	X 3.47	X 4.91	X 64.15	X 1.26		X 2.28	C 1.20	K 0.34	X 0.15	X 0.52	X 0.13		X 0.26				
28	K 0.86	X 21.26	X 3.39	X 5.00	X 64.60	X 1.29	X 0.15	X 2.29	G 0.98	K 0.10	X 0.16	X 0.50	X 0.13	X 0.005	X 0.27	X 0.09			0.000033
29	N 0.88	X 21.24	X 3.42	X 4.93	X 64.55	X 1.28	X 0.14	K 2.30	G 1.30	K 0.32	X 0.20	X 0.50	X 0.14	P 0.013	X 0.27			P 0.003	0.000078
29								X 2.35											
30	K 0.91	K 21.15	K 3.46	K 4.90	K 64.10	K 1.23	X 0.14	K 2.33	G 1.13	K 0.33	K 0.22	K 0.50	X 0.14	M 0.005	X 0.26	X 0.09		K 0.000	0.000000
31	K 0.91	X 20.65	X 3.81	X 4.99	X 65.59	X 1.09		X 2.03	G 1.52	K 0.24	X 0.17	X 0.48		X 0.000	X 0.27			P 0.000	N 0.000000
31	K 1.18	X 20.64	X 3.79	X 4.99	X 65.40	X 1.09		X 1.99		K 0.79	X 0.17	X 0.47			X 0.26				
32	K 0.86	X 20.49	X 3.20	X 4.95	X 64.20	X 1.23	X 0.14	K 2.29	N 1.25	K 0.62	X 0.16	X 0.51	X 0.13	P 0.010	X 0.26		0.00	P 0.006	N 0.300000
32	K 0.86							X 2.16											
32	D 1.40																		
32	B 1.40																		
33	K 0.86	X 21.26	X 3.44	X 4.95	X 64.50	X 1.26	X 0.13	K 2.25	C 1.15	K 0.27	X 0.23	X 0.51	X 0.13	P 0.007	X 0.27			P 0.000	N 0.000115
33								X 2.35						X 0.009					
34	K 0.98	X 21.31	X 3.46	X 4.82	X 64.21	X 1.23		K 2.36	C 1.11	K 0.23	X 0.22	X 0.51	X 0.13	M 0.001	X 0.26			0.006	K 0.000037
34								K 2.31						X 0.000					
34								X 2.35											
35	K 0.93	X 21.23	X 3.40	X 4.88	X 64.83	X 1.21		K 2.26	G 1.28	K 0.07	X 0.18	X 0.50	X 0.18	X 0.010	X 0.27			0.000	K 0.000199
35	K 0.87	X 21.18	X 3.41	X 4.88	X 64.88	X 1.21		K 2.25		K 0.06	X 0.19	X 0.51	X 0.19		X 0.27				
35								X 2.41											
35								X 2.42											
36	K 0.84	X 21.30	X 3.42	X 4.92	X 64.61	X 1.23		K 2.32	G 1.32	K 0.35	X 0.20	X 0.52			X 0.26			0.022	0.000089
36	K 0.87	X 21.34	X 3.43	X 4.93	X 64.70	X 1.24					X 0.20	X 0.53			X 0.26				
37	K 0.87	X 21.40	X 4.85	X 3.38	X 64.55	X 1.24		K 2.34		K 0.31	X 0.28	X 0.52		X 0.001					
37	K 0.96	X 21.53	X 4.85	X 3.40	X 64.68	X 1.25		N 2.32			X 0.28	X 0.52		N 0.000					

Labs	Loss on ignition (%)	SiO2 (%)	Al2O3 (%)	Fe2O3 (%)	CaO (%)	MgO (%)	MnO (%)	SO3 (%)	Free lime (%)	Insoluble residue (%)	Na2O (%)	K2O (%)	TiO2 (%)	Chloride (%)	P2O5 (%)	SrO (%)	CO2 (%)	S-- (%)	Cr6+ (%)
38	K 0.95	X 21.64	X 3.40	X 4.87	X 64.33	X 1.27		K 2.34	G 0.73	K 0.26	X 0.20	X 0.51	X 0.12	P 0.044				0.000	0.000084
38								X 2.27											
39	K 1.05	X 21.07	X 3.39	X 4.82	X 64.20	X 1.28	X 0.12	K 2.35	G 1.62	K 0.32	X 0.15	X 0.52	X 0.13	X 0.004	X 0.28				
39	K 1.08	X 21.07	X 3.40	X 4.79	X 64.12	X 1.27	N 0.12	K 2.38	C 1.46	K 0.34	X 0.12	X 0.51	X 0.13		X 0.27				
40	K 0.83	X 21.14	X 3.43	X 5.01	X 64.54	X 1.19		K 2.17	G 0.65	K 0.39	X 0.20	X 0.54		X 0.000	X 0.31			0.035	0.000030
40	K 0.81	X 21.31	X 3.42	X 5.02	X 64.58	X 1.20		K 2.22		K 0.37	X 0.20	X 0.55			X 0.31				
40								X 2.23											
40								X 2.21											
41	K 1.00	X 21.35	X 3.47	X 4.98	X 64.45	X 1.11		K 2.33	G 1.46	K 0.27	X 0.20	X 0.46		X 0.010	X 0.25			0.053	0.000040
41								X 2.25											
42	K 0.84	X 20.85	X 3.34	X 4.76	X 64.94	X 1.26	X 0.12	K 2.49	G 1.32	K 0.70	X 0.16	X 0.54	X 0.13	X 0.010	X 0.26	X 0.09	0.36		0.000090
42	K 0.86	X 20.89	X 3.33	X 4.76	X 64.83	X 1.23		K 2.24	C 1.39	K 0.25	X 0.17	X 0.53							
42								X 2.32											
42								X 2.29											
43	K 0.81	X 21.40	X 3.42	X 4.93	X 64.61	X 1.31		K 2.30	G 1.25	K 0.35	X 0.20	X 0.52	X 0.14						
44	K 0.83							N 2.35						M 0.010					
44	K 0.80																		
45	K 0.80	X 21.40	X 3.40	X 4.90	X 64.63	X 1.24	X 0.15	K 2.27	G 1.20	K 0.28	X 0.17	X 0.51	X 0.13	X 0.001	X 0.26	X 0.08		0.018	0.000080
45	K 0.81	X 21.29	X 3.41	X 4.92	X 64.71	X 1.23	X 0.15	K 2.29		K 0.30	X 0.18	X 0.52	X 0.14		X 0.26	X 0.08			
46	D 1.27							K 2.28		K 0.33									
47	K 0.87	X 21.37	X 3.40	X 4.83	X 64.67	X 1.24		X 2.30	C 1.05	K 0.29	X 0.20	X 0.52	X 0.15	P 0.011	X 0.28			P 0.001	0.000030
47								N 2.37											
48	K 0.85	X 21.34	X 3.47	X 4.88	X 64.47	X 1.26		K 2.28	C 1.20	K 0.22	X 0.24	X 0.51	X 0.14	P 0.003	X 0.27			P 0.000	N 0.000061
48								X 2.31											
49	K 0.86	X 21.38	X 3.48	X 4.91	X 64.83	X 1.30	X 0.15	K 2.43	G 1.36	K 0.28	X 0.22	X 0.51	X 0.13	P 0.009	X 0.27	X 0.09	0.53		0.000101
49								X 2.39											
50	K 0.89	X 21.37	X 3.46	X 4.88	X 64.18	X 1.26	X 0.14	K 2.35	C 1.28	K 0.28	X 0.24	X 0.52	X 0.13	P 0.008	X 0.26	X 0.09	K 0.53	P 0.000	K 0.000104
50								X 2.39											
51	K 0.85	X 22.95	X 3.49	X 4.81	X 64.20	X 1.30	X 0.12	X 1.80	G 1.26		X 0.21	X 0.45	X 0.13	M 0.004	X 0.27	X 0.08	N 0.46		N 0.000012
51	K 1.04	X 23.10	X 3.53	X 4.78	X 64.48	X 1.33	X 0.12	X 1.86	N 1.59		X 0.22	X 0.46	X 0.12	K 0.004	X 0.27	X 0.08			
51	D 1.10							N 2.38											
51	B 0.92																		
51	N 0.35																		
52	K 0.89	X 21.34	X 3.51	X 4.89	X 64.38	X 1.26	X 0.15	K 2.32			X 0.23	X 0.50	X 0.13	P 0.005	X 0.27	X 0.09		P 0.001	K 0.000065
52								X 2.34											
53	K 1.03	X 21.32	X 3.48	X 4.90	X 64.27	X 1.26	X 0.15	K 2.27	C 1.16	K 0.44	X 0.22	X 0.50	X 0.13	P 0.005	X 0.27	X 0.09			
53	K 1.04	X 21.35	X 3.47	X 4.89	X 64.30	X 1.26	X 0.15	K 2.28	C 1.15	K 0.40	X 0.21	X 0.50	X 0.13		X 0.27	X 0.09			
53								X 2.32											
53								X 2.31											
54	K 0.84	X 21.40	X 3.52	X 4.88	X 64.29	X 1.28	X 0.07	X 2.33	C 1.13		X 0.23	X 0.51	X 0.12	P 0.008	X 0.26	X 0.09		P 0.000	0.000100
54	K 0.85	X 21.41	X 3.52	X 4.88	X 64.40	X 1.28	X 0.07	X 2.31	C 1.15		X 0.23	X 0.51	X 0.13		X 0.26	X 0.09			
55		X 19.52	X 3.15	X 4.85	X 59.99	X 1.09		X 2.15			X 0.11	X 0.36		X 0.001					
56	K 0.85	N 21.99	N 3.98	N 4.56	N 62.61	N 0.79		N 2.19	N 1.04	K 0.27		N 0.53		N 0.020					
57	K 0.96							K 2.31		K 0.47									0.000006
57	K 1.02							K 2.21		K 0.51									
58	D 0.74	X 21.16	X 3.47	X 4.84	X 64.44	X 1.20	X 0.15	X 2.32		K 0.27	X 0.17	X 0.49	X 0.12	P 0.018	X 0.27			P 0.000	0.000012
58								N 2.33											
59	K 0.92	X 21.33			X 64.28			K 2.28	C 1.15	K 0.43									0.000060
59	K 0.93	X 21.34			X 64.31			X 2.31	C 1.14	K 0.42									
59								X 2.32											
60	N 0.81	X 21.33	X 3.47	X 5.10	X 64.47	X 1.22	X 0.15	K 2.13	G 2.03	K 0.22	X 0.17	X 0.50	X 0.14	X 0.002	X 0.27	X 0.08			
60								X 2.28											
61	K 0.80	X 21.11	X 3.43	X 4.95	X 65.15	X 1.24		X 2.22	G 1.47		X 0.19	X 0.51	X 0.12	X 0.010	X 0.27				
62	K 0.89	X 21.46	X 3.51	X 4.97	X 64.76	X 1.25	X 0.13	N 2.36	G 1.29	N 0.26	M 0.21	M 0.50	X 0.16	P 0.007	X 0.26	X 0.08	N 0.46	K 0.009	N 0.000291
70	N 0.77	M 21.57	M 3.34	M 4.67	M 64.12	M 1.20		K 2.41	G 1.17		M 0.24	M 0.55		M 0.010					
74	K 0.84							K 2.25											
74	K 0.86							K 2.22											
75	K 1.44							K 1.76		K 0.19				M 0.020					
76	K 1.03	X 21.28	X 3.47	X 4.88	X 64.70	X 1.22		X 2.26	G 1.03		X 0.28	X 0.62	X 0.14	N 0.030	X 0.27	X 0.09			
76								N 2.27											
77	D 0.82							K 2.24		K 0.35				M 0.010					
82		X 17.55	X 3.26	X 5.29	X 67.69	X 1.60	X 0.15	X 3.14					X 0.12		X 0.09	X 0.10			
82		X 17.53	X 3.26	X 5.30	X 67.70	X 1.60	X 0.15	X 3.13					X 0.13		X 0.08	X 0.11			
83	K 1.04	M 21.23	M 3.42	M 4.92	M 64.20	M 1.25	N 0.13	K 2.41	G 1.30	K 0.32	K 0.22	K 0.48	N 0.13	M 0.007	N 0.26	N 0.10		K 0.025	
83	K 1.12							K 2.39		K 0.33				K 0.007					
83a	K 1.04	M 21.36	M 3.50	M 4.79	M 64.45	M 1.23	N 0.13	K 2.41	G 1.31	K 0.41	K 0.22	K 0.49	N 0.13	M 0.011	N 0.27	N 0.10	0.37	K 0.016	0.000009
83a	K 1.04							K 2.38		K 0.41				K 0.011					
83b								K 2.29		K 0.42	K 0.23	X 0.48							
83b								K 2.39		K 0.43									
83e		M 21.38	M 3.43	M 4.89	M 64.50	M 1.25	N 0.13	K 2.28	G 1.25	K 0.47	K 0.22	K 0.46	N 0.13	M 0.004	N 0.26	N 0.10	K 0.35	K 0.017	K 0.000007
83e								K 2.37		K 0.40									
83f	K 1.07							K 2.43		K 0.35				M 0.011				K 0.015	
83f	K 1.09							K 2.45		K 0.31				K 0.007					
84	K 0.76	M 21.68	M 3.42	M 5.75	M 64.22	M 1.32	N 0.13	K 1.91		K 0.63	M 0.28	M 0.53	N 0.13	M 0.004					
84	K 0.79							K 1.93		K 0.64				K 0.002					
86	B 1.05	M 25.66	M 3.76	M 5.21	M 59.02	M 0.71	N 0.07	K 2.21			M 0.24	M 0.43	N 0.07	P 0.000	N 0.18			P 0.000	
100	K 1.08	X 21.36	X 3.44	X 4.94	X 63.98	X 1.25	X 0.12	K 2.27	C 1.08	K 0.14	K 0.33	K 0.68	X 0.13	M 0.010	X 0.27	X 0.09	0.35	K 0.010	
100	K 1.02	X 21.41	X 3.44	X 4.95	X 64.12	X 1.25	X 0.12	K 2.26	C 1.10	K 0.15	K 0.34	X 0.51	X 0.13	K 0.010	X 0.27	X 0.09			

Labs	Loss on ignition (%)	SiO2 (%)	Al2O3 (%)	Fe2O3 (%)	CaO (%)	MgO (%)	MnO (%)	SO3 (%)	Free lime (%)	Insoluble residue (%)	Na2O (%)	K2O (%)	TiO2 (%)	Chloride (%)	P2O5 (%)	SrO (%)	CO2 (%)	S-- (%)	Cr6+ (%)
100			M 3.65	M 4.86	M 62.82	M 1.23	N 0.13	X 2.34			X 0.20	X 0.51	N 0.12	P 0.010	N 0.23	N 0.09			
100								X 2.33			X 0.21	M 0.60							
100								N 2.33			M 0.43	N 0.43							
100											N 0.23								
101	K 0.84	K 21.48	K 3.38	K 4.83	K 64.62	K 1.25		K 2.39	G 1.40	K 0.19	K 0.22	K 0.51	X 0.14	M 0.007	X 0.26				
101		X 21.36	X 3.43	X 4.90	X 64.26	X 1.28		N 2.32			X 0.23	X 0.55		X 0.055					
102	K 0.99	K 21.04	K 3.90	K 4.79	K 63.93	K 1.40		K 2.33	G 1.49	K 0.20	K 0.18	K 0.45		M 0.004					K 0.000060
102	K 1.01	K 21.00	K 3.90	K 4.89	K 64.07	K 1.30		K 2.29	C 1.51	K 0.21	K 0.16	X 0.43		K 0.001					
103	K 0.76	K 21.35	K 3.35	K 4.91	K 64.01	K 1.24		K 2.35	C 1.13	K 0.23	K 0.20	K 0.52		M 0.005					K 0.000050
103	K 0.86		K 3.29	K 5.15	K 64.22			K 2.26			K 0.21								
104	N 0.80	X 21.43	X 3.56	X 4.89	X 64.98	X 1.34	X 0.13	X 2.39	G 0.97	K 0.43	X 0.20	X 0.52	X 0.14	P 0.006	X 0.27	X 0.08			K 0.000159
104								N 2.41											
105	N 1.00	X 21.50	X 3.63	X 4.87	X 65.20	X 1.24	X 0.00	X 2.40	G 1.18		X 0.21	X 0.49	X 0.12	X 0.000	X 0.24	X 0.08			
106	K 0.85	X 21.12	X 3.53	X 4.91	X 64.99	X 1.25	X 0.16	X 2.19	G 1.00	K 0.13	X 0.28	X 0.48	X 0.16	P 0.015	X 0.30				0.000095
106	K 0.86	X 21.19	X 3.53	X 4.95	X 65.10	X 1.27	X 0.17	X 2.21		K 0.15	X 0.28	X 0.48	X 0.16		X 0.30				
107	N 0.89	X 21.49	X 3.57	X 4.87	X 64.52	X 1.31	X 0.14	X 2.25	G 1.28	K 0.22	X 0.25	X 0.51	X 0.13	M 0.006	X 0.27	X 0.09	N 0.42		K 0.000134
107		X 21.40	X 3.54	X 4.88	X 64.44	X 1.30	X 0.13	X 2.36			X 0.25	X 0.51	X 0.13		X 0.27	X 0.09			
107								N 2.34											
108	K 0.87	X 21.33	X 3.59	X 4.98	X 65.27	X 1.29	X 0.14	N 2.41		K 0.12	X 0.23	X 0.52	X 0.13	P 0.008	X 0.27	X 0.09	0.35		0.000025
109	K 0.95	X 21.25	X 3.41	X 4.71	X 64.21	X 1.26	X 0.13	X 2.44		K 0.25	X 0.17	X 0.53	X 0.12	X 0.006	X 0.26	X 0.09	N 0.48		K 0.000055
110	K 0.92	X 21.34	X 3.34	X 4.90	X 64.69	X 1.30		X 2.30	C 1.28	K 0.33	X 0.19	X 0.46	X 0.13	X 0.006	X 0.25	X 0.08			
110	K 0.95	X 21.32	X 3.34	X 4.89	X 64.61	X 1.31		X 2.30	C 1.24	K 0.34	X 0.19	X 0.46	X 0.13		X 0.25	X 0.08			
111	K 1.08	K 21.29	X 3.39	X 4.86	X 65.02	X 1.26	X 0.15	K 2.36	G 1.27	K 0.35	K 0.25	K 0.52	X 0.13	M 0.001	X 0.27	X 0.09			
111	K 1.08	K 21.29	X 3.40	X 4.87	X 64.94	X 1.26	X 0.15	K 2.34	N 1.25	K 0.34	K 0.24	X 0.52	X 0.13	K 0.002	X 0.27	X 0.09			
111	D 0.83							X 2.32			X 0.23	X 0.52		X 0.005					
111	B 0.84							X 2.36			X 0.23	A 0.52		N 0.003					
112	K 0.85	K 21.48	K 3.38	K 4.88	K 64.19	K 1.56		K 2.12	N 1.03	K 0.34				M 0.024					0.000113
113	K 0.87	K 21.46	K 3.69	K 4.66	K 63.65	K 1.55		K 2.36	N 1.23	K 0.19	K 0.12	K 0.46		M 0.010			0.43		
114	K 1.05	K 21.52	K 3.45	K 4.74	K 63.98	K 1.21		K 2.19	N 1.35	K 0.32	K 0.19	K 0.50		M 0.010			0.40		0.000130
114	K 1.01	K 21.46	K 3.47	K 4.77	K 63.75	K 1.21		K 2.21		K 0.30	K 0.21			K 0.010					
115	N 1.16	X 20.77	X 3.80	X 4.96	X 61.73	K 1.36		X 2.00		K 0.22	X 0.22	X 0.45	X 0.14		X 0.24				K 0.000037
116	K 1.02	X 21.36	X 3.52	X 4.89	X 64.04	X 1.32		X 2.35	C 1.27	K 0.48	X 0.20	X 0.49	X 0.14	P 0.006	X 0.26	X 0.10			N 0.000019
116	K 0.98	X 21.42	X 3.50	X 4.86	X 64.14	X 1.30		X 2.36	C 1.25	K 0.51	X 0.20	X 0.49	X 0.14		X 0.26	X 0.10			
117	K 1.48	X 21.57	X 3.46	X 4.90	X 64.67	X 1.30	X 0.13	X 2.32		K 0.23	X 0.23	X 0.51	X 0.14	N 0.004	X 0.27	X 0.09			0.000461
117								N 2.26											
118	N 1.00	X 20.98	X 3.48	X 4.95	X 64.14	X 1.32	X 0.13	X 2.30	C 1.37		X 0.21	X 0.52	X 0.13	X 0.008	X 0.25	X 0.09	0.44		
118								N 2.36											
119	N 1.10	X 21.03	X 3.55	X 4.77	X 63.94	X 1.40	X 0.16	N 2.36	G 1.15	K 0.18	X 0.28	X 0.50	X 0.13	N 0.005	X 0.25	X 0.09	0.25		0.000010
119		M 19.04	M 3.54	M 4.97	M 66.62	M 1.31	N 0.15				M 0.21	M 0.51	N 0.13		N 0.27	N 0.09			
120	N 0.89	N 21.36	N 3.42	N 5.18	N 63.94	N 1.44		N 1.63	N 1.14	K 0.62	K 0.16	K 0.34		M 0.010			0.67		0.000050
121	K 1.42	K 21.28	K 3.23	K 5.19	K 63.80	K 1.42		K 2.63	B 0.90	K 0.61	X 0.14	X 0.48		M 0.012					K 0.000008
121	K 1.51	K 21.34	K 3.47	K 5.20	K 63.60	K 1.39		K 2.41		K 0.72				K 0.021					
122	K 0.83	K 21.56	K 3.36	K 4.93	K 64.81	K 1.28	X 0.13	K 2.47	N 0.97	K 0.32	X 0.21	X 0.52		M 0.007					0.000000
122		X 21.52	X 3.28	X 4.79	X 64.68	X 1.25		X 2.30											
123	K 0.84	K 21.05	K 3.68	K 5.04	K 64.12	K 1.57		K 2.30	G 0.87	K 0.37				M 0.011					0.000148
123	K 0.88	K 21.09	K 3.75	K 4.98	K 64.35	K 1.57		K 2.24	C 0.91	K 0.37				K 0.009					
124	K 0.98							N 2.47						M 0.010			N 0.37		
125	K 0.84	K 20.95	K 3.74	K 4.74	K 63.37	K 1.25		K 2.30	G 0.64	K 0.53	X 0.20	X 0.52	X 0.13	M 0.008	X 0.26	X 0.09			K 0.000533
125	K 0.86	X 21.38	X 3.62	X 5.05	X 63.96	X 1.29		K 2.23	N 0.50					K 0.008					
125								X 2.42											
126	K 1.00	K 21.31	K 3.44	K 4.85	K 64.26	K 1.30	N 0.13	K 2.33	G 1.11	K 0.26	A 0.23	A 0.54	N 0.13	M 0.006	N 0.29	N 0.10	K 0.33	K 0.027	K 0.000004
126		K 21.40	N 3.40	N 4.84	N 64.42	N 1.24		N 2.33						N 0.007					
126a	D 1.15	K 20.97	K 3.59		K 64.98	K 1.20		K 2.46	G 0.81	K 1.58	A 0.19	A 0.46	N 0.15	P 0.020					
126a	B 1.18	K 20.80	K 3.53		K 64.98	K 1.21		K 2.40		K 1.62	N 0.20	N 0.45							
127	K 0.86	K 21.52	K 3.57	K 4.93	K 64.63	K 1.27		K 2.19	G 1.18	K 0.27	K 0.20	K 0.49		M 0.012					0.000002
128	K 0.84	K 21.34	K 3.45	K 4.66	K 63.53	K 1.91	X 0.11	K 2.30	G 0.41		K 0.15	K 0.48	N 0.11	M 0.020	N 0.16	N 0.26	0.40		0.000066
128									N 0.42										
129	K 0.83	X 23.29	K 3.46	K 4.90	X 66.30	X 0.99	X 0.13	K 2.20		K 0.29	X 0.09	X 0.46	X 0.15	M 0.006	X 0.28	X 0.07	N 0.37		K 0.000070
129			X 3.68	X 5.05				X 1.83											
129								N 2.25											
130	K 1.18	X 21.31	X 3.16	X 4.87	X 64.81	X 1.39	X 0.08	X 2.10	G 1.00	K 0.30	X 0.19	X 0.46	X 0.14	X 0.015	X 0.30		N 0.96		K 0.000103
130	N 1.36							N 2.36											
131	K 0.99	X 21.36	X 3.47	X 4.98	X 64.05	X 1.25	X 0.18	K 2.32	G 1.31	K 0.60	X 0.23	X 0.50	X 0.15	M 0.009	X 0.27	X 0.13	N 0.40		K 0.000270
131	K 1.01	X 21.27	X 3.45	X 4.94	X 64.39	X 1.28	X 0.18	K 2.33		K 0.74	X 0.26	X 0.49	X 0.13	K 0.006	X 0.27	X 0.16			
131								X 2.30											
131								X 2.34											
132	K 0.96																		
132	K 0.97																		
132	N 1.03																		
133	K 0.95	K 22.25	K 5.30	K 4.30	K 60.60	K 1.95		K 2.40		K 0.47	K 0.24	K 0.50		M 0.020					0.000100
134	D 0.83	X 21.35	X 3.45	X 4.91	X 64.44	X 1.28	X 0.14	X 2.32	C 1.07	K 0.18	A 0.21	A 0.52	X 0.13	M 0.009	X 0.27	X 0.09			K 0.000035
135	K 1.09	K 20.80	K 3.67	K 5.11	K 66.60	K 1.42	X 0.14	K 2.23	G 0.99	K 0.39	X 0.11	X 0.51	X 0.13	M 0.009	X 0.24	X 0.08	N 0.50	K 0.020	K 0.000173
135	K 1.10	K 21.16	K 3.10	K 4.61	K 65.66	K 1.38	X 0.14	K 2.25	C 0.85		X 0.13	X 0.48	X 0.13	K 0.009	X 0.26	X 0.08			
135		X 20.10	X 2.49	X 4.55	X 63.09	X 1.21		X 2.36	N 0.40		A 0.27	A 0.47		P 0.001					
135		X 20.50	X 2.51	X 4.65	X 64.15	X 1.23		X 2.24						X 0.008					
136	N 2.51	X 19.32	X 4.98	X 2.79	X 62.53	X 1.94		X 3.41	G 1.70	K 0.20	X 0.22	X 0.87	X 0.34	M 0.072	X 0.47	X 0.08			
137	K 0.98	X 21.32	X 3.47	X 4.77	X 64.32	X 1.27	X 0.11	X 2.39	N 1.17	K 0.15	X 0.20	X 0.53	X 0.13	N 0.004	X 0.27	X 0.09			0.000028
137	K 0.96	X 21.25	X 3.45	X 4.83	X 64.32	X 1.27	X 0.11	X 2.41		K 0.15	X 0.19	X 0.51	X 0.12		X 0.26	X 0.10			

Labs	Loss on ignition (%)	SiO2 (%)	Al2O3 (%)	Fe2O3 (%)	CaO (%)	MgO (%)	MnO (%)	SO3 (%)	Free lime (%)	Insoluble residue (%)	Na2O (%)	K2O (%)	TiO2 (%)	Chloride (%)	P2O5 (%)	SrO (%)	CO2 (%)	S-- (%)	Cr6+ (%)
138	K 1.24	X 21.81	X 4.73	X 4.81	X 63.80	X 1.66	X 0.15	X 2.46			X 0.13	X 0.58	X 0.18		X 0.33	X 0.08			
138	K 1.23	X 21.26	X 4.60	X 4.75	X 63.55	X 1.61	X 0.14	X 2.48			X 0.16	X 0.59	X 0.18		X 0.31	X 0.08			
139	K 0.67	X 22.67	X 3.45	X 4.52	X 64.04	X 1.32	X 0.11	K 2.37	C 0.99	K 0.37	X 0.16	X 0.47	X 0.12	P 0.003	X 0.27	X 0.08	N 0.21		
139	K 0.70	X 21.06	X 3.41	X 4.88	X 64.30	X 1.28	X 0.11	K 2.40	C 1.07	K 0.38	X 0.21	X 0.50	X 0.14	X 0.002	X 0.26	X 0.09			
139								X 2.21						N 0.006					
139								X 2.55											
140	K 0.92	X 21.12	X 3.43	X 4.85	X 64.31	X 1.28	X 0.13	X 2.61	N 1.10		X 0.22	X 0.51	X 0.13		X 0.26		N 0.62		
141	K 0.93	K 21.31	K 3.49	K 4.83	K 63.97	K 1.24	X 0.15	K 2.33	G 1.16	K 0.26	X 0.21	X 0.49	X 0.14	K 0.008	X 0.27	X 0.08	N 0.40	K 0.024	K 0.000025
141	N 0.87	X 21.30	X 3.41	X 4.89	X 64.47	X 1.22		X 2.27			A 0.19	A 0.50							
142	K 0.88	X 21.33	X 3.43	X 4.90	X 64.50	X 1.24		X 2.32	C 1.07	K 0.19	X 0.21	X 0.51	X 0.13	M 0.009	X 0.28				K 0.000035
142	K 0.88	X 21.33	X 3.43	X 4.90	X 64.52	X 1.24		X 2.32	C 1.08	K 0.18	X 0.21	X 0.51	X 0.13		X 0.28				
143	K 0.89	X 21.37	X 3.82	X 5.09	X 64.93	X 1.41	X 0.14	X 2.06	G 1.45	K 0.43	X 0.17	X 0.47	X 0.13	X 0.004	X 0.25	X 0.10		K 0.072	0.000105
144	K 0.86	X 21.31	X 3.45	X 4.85	X 64.45	X 1.24	X 0.15	K 2.27	G 1.36	K 0.30	X 0.24	X 0.50	X 0.14	P 0.005	X 0.25	X 0.09			K 0.000060
144								X 2.30											
145	K 0.90	X 21.45	X 3.45	X 4.82	X 64.38	X 1.26	X 0.15	X 2.36	G 1.19	K 0.27	X 0.20	X 0.50	X 0.13	M 0.007	X 0.26	X 0.08			0.000035
146	K 0.95	X 21.34	X 3.42	X 4.80	X 64.44	X 1.30		K 2.30	G 1.26	K 0.28	K 0.25	K 0.50		M 0.006					K 0.000050
146								X 2.28			X 0.23	X 0.51		X 0.000					
147	K 1.06	X 21.50	X 3.60	X 4.80	X 64.00	X 1.27		K 2.22	G 1.07	K 0.63	K 0.20	X 0.51	X 0.16	M 0.008	X 0.26			K 0.000	K 0.000275
147	K 1.11	X 21.60	X 3.60	X 4.80	X 63.80	X 1.29		K 2.20		K 0.65	K 0.20	X 0.51	X 0.15	K 0.009	X 0.26				
148	K 0.77	K 21.00	K 3.64	K 5.01	K 64.43	K 1.31		K 2.34	G 1.27		X 0.16	X 0.46	X 0.15		X 0.26	X 0.09	N 0.33		K 0.000060
148		X 21.00	X 3.34	X 4.78	X 63.85	X 1.33		K 2.31											
148								X 2.35											
148								N 2.37											
149	K 0.95	K 21.19	K 3.67	K 4.83	K 64.44	K 1.34	X 0.13	K 2.39	G 1.26	K 0.39	X 0.19	X 0.48	X 0.13	M 0.010	X 0.25	X 0.10	N 0.39		K 0.000030
149	N 1.02	X 21.25	X 3.31	X 4.99	X 64.48	X 1.24		X 2.22			X 0.25	X 0.45		X 0.000					
149								N 2.42											
150	K 0.85	X 21.42	X 3.30	X 4.76	X 64.14	X 1.29	X 0.14	X 2.35	G 0.95	K 0.42	X 0.20	X 0.44	X 0.15	M 0.006	X 0.26			0.000	0.000084
150	K 0.88	X 21.23	X 3.26	X 4.72	X 63.99	X 1.33	X 0.14	X 2.37	N 0.95	K 0.45	X 0.20	X 0.45	X 0.16	X 0.007	X 0.26				
150										X 0.55									
151	N 0.92	X 21.38	X 3.44	X 4.97	X 64.91	X 1.23	X 0.12	X 2.29		K 0.03	X 0.21	X 0.53	X 0.14		X 0.27	X 0.09			
151								N 2.36											
152	K 1.26	X 21.61	X 3.50	X 4.86	X 64.48	X 1.26	X 0.06	X 2.25	C 0.96	K 0.63	X 0.20	X 0.51	X 0.14	P 0.013	X 0.26	X 0.08		K 0.060	0.000168
152	K 1.24	X 21.60	X 3.50	X 4.88	X 64.45	X 1.26	X 0.06	X 2.27	C 0.95	K 0.62	X 0.20	X 0.51	X 0.14		X 0.26	X 0.08			
153	K 0.98	K 21.24	K 3.59	K 4.98	K 63.98	K 1.35	X 0.15	K 2.31	C 1.25	K 0.23	K 0.22	K 0.45	X 0.12	M 0.007	X 0.27	X 0.09	0.26		0.000070
153	K 0.94	K 21.24	K 3.57	K 4.99	K 63.96	K 1.36		K 2.31	C 1.26	K 0.21	K 0.22	X 0.48		K 0.008					
153		X 21.31	X 3.48	X 4.92	X 64.40	X 1.31		X 2.29			X 0.22								
154	K 0.80	X 21.41	X 3.70	X 5.00	X 64.70	X 1.61		X 2.21	G 0.87	K 0.42	X 0.19	X 0.55		M 0.010					
154	K 0.80	X 21.40	X 3.68	X 5.01	X 64.71	X 1.60		X 2.22		K 0.40	X 0.19	X 0.57		K 0.010					
155	D 1.00	M 21.40	M 3.48	M 4.80	M 64.22	M 1.25	N 0.12	N 2.45	N 1.31	K 0.30	M 0.21	M 0.54	N 0.11	P 0.009	N 0.26	N 0.07	N 0.39		
157	K 1.12	X 21.46	X 3.54	X 4.98	X 64.79	X 1.32		X 2.31	G 0.83		K 0.18	X 0.48		X 0.000	X 0.25				
157	K 1.05	X 21.38	X 3.57	X 4.95	X 64.69	X 1.25		X 2.23			K 0.17	X 0.50			X 0.27				
158	D 0.87	X 21.65	X 3.23	X 4.82	X 64.79	X 1.81	X 0.12	X 2.21				X 0.54	X 0.12		X 0.56				
158	B 0.89	X 21.78	X 3.41	X 4.84	X 65,02	X 1.84	X 0.10	X 2.28				X 0.43	X 0.13		X 0.67				

Labs	Specific Gravity (g/cm3)	Specific Surface (cm^2/g)	Corrected Surface (cm^2/g)	Normal concistency (%)	Initial Setting Time (min)	Soundness (mn)	Workability (s)
1	A 3.20	N 4980	4919	30.5	A 170	0.50	
2	A 3.29	A 4645	4379	29.2	A 165	0.00	
2a	A 3.15	A 4665	4725	29.2	A 145	1.00	
3	A 3.19	N 5050	5014	30.3	A 188	1.90	
4	V 3.21	N 4924	4842	30.8	A 154	0.54	
4	V 3.21			30.6	A 148	0.12	
5a	V 3.19	A 5221	5157	30.5	A 195	0.10	
5a	V 3.21				A 185	0.20	
6	V 3.20	A 4640	4583	30.0	M 180	1.00	
7	A 3.20	A 4695	4638	30.4	A 163	0.00	
7	A 3.20			30.1	A 147	0.00	
8	V 3.21	N 4980	4894	30.8	A 160	1.50	
9	A 3.19	G 4730	4696	32.0	A 172	0.00	
10	V 3.27	G 4206	4007	28.8	A 165	1.00	
10	V 3.27	N 5865	5588	29.6	A 190	0.00	
10				29.2	M 175		
11	V 3.16	A 4670	4706	30.5	A 190	1.00	
12	A 3.17	A 4747	4770	30.0	M 190	0.00	
13	A 3.21	G 4922	4813	32.2	A 182	1.00	
13	A 3.22						
14				30.0	A 165	0.00	
14				30.0	A 155	0.00	
15	V 3.19	G 4949	4914	30.0	A 185	1.0	
15				30.0	A 190	1.0	
20	A 3.20	G 4863	4804	29.0	A 170		
20				29.0	A 160		
21	A 3.19	A 4792	4757	30.5	A 178		
21				31.0	A 186		
21				30.8	M 185		
21				30.8	M 171		
22	V 3.19	A 4991	4955	31.9	A 195	0.00	
23	A 3.18	A 4736	4726	30.6	A 207	0.00	
24	A 3.18	N 4893	4882				
25	A 3.18	A 4870	4859	31.6	A 200	2.00	
26	A 3.18	N 5011	5000	30.7	A 179	1.00	
27	A 3.20	A 4840	4781				
28	A 3.22	G 4910	4801	32.5	A 175	0.50	
29	V 3.18	G 4920	4897	32.4	A 210	0.50	
29	V 3.19						
30	A 3.18	A 4815	4804	30.8	A 197	0.00	
31	A 3.18	G 4733	4723	31.0	A 188	0.00	
31		N 4669	4659	31.6	A 199	0.50	
32	V 2.71	G 3846	4741	33.0	A 178	0.50	
33	A 3.18	A 4850	4839	30.3	A 186	0.00	
34	A 3.18	L 4870	4859	32.1	A 207	1.00	
34				32.0		1.00	
34				32.2			
35	A 3.20	G 4840	4781	30.8	A 190	0.00	
35	A 3.20			30.8	A 190	0.00	
36	V 3.19	G 4928	4893	31.6	A 180	0.00	
37				30.9	A 196	0.00	
38	V 3.16	G 4877	4915	30.4	A 170	0.50	
38				30.2	A 175	0.10	
39	V 3.11	G 4697	4851	32.6	M 205	0.00	
39				32.6	M 200	0.00	
40	A 3.18	G 4920	4909	34.2	A 190		
40				34.2	M 215		
41	V 3.05	G 4695	4997	30.6	A 199	1.00	
41				30.6	A 192		
42				31.6	A 185	1.00	
42				31.6	A 200		
43	V 3.20	G 5021	4960	32.8	A 204	0.00	
44	A 3.18	G 5109	5098	31.0	A 200	1.00	
44	A 3.18				A 185	0.50	
45	V 3.17	G 4826	4827	32.1	A 200	0.00	
45	V 3.18			32.3	M 195	0.00	
46	V 3.14	G 4506	4586		A 160		

Labs	Specific Gravity (g/cm3)	Specific Surface (cm^2/g)	Corrected Surface (cm^2/g)	Normal concistency (%)	Initial Setting Time (min)	Soundness (mn)	Workability (s)
46					M 160		
47	A 3.17	G 4820	4834	30.8	A 235	1.21	2.1
47							2.4
48	A 3.18	A 4800	4789	30.6	A 206	0.50	
49	A 3.20	G 4556	4500	31.0	A 187	1.00	
50		A 4828		31.0	A 203	0.50	
51	A 3.15	G 4640	4699	30.9	A 241	1.00	
51					M 236		
52	V 3.19	A 4865	4837	31.3	A 202	1.50	
53		A 4855					
54		G 4740		31.1	A 194	0.50	
54				31.5	A 196	0.50	
54				31.5	M 245		
54					M 253		
55	A 3.14	G 4081	4154	29.0	M 145	0.83	
56				32.2	M 195	1.00	
57				32.9	M 207		
57				32.9	M 208		
58		G 4986					
59		A 4845		32.4	A 214	0.50	
59				32.3	A 211	1.00	
60	V 3.18	G 4531	4521		A 140	0.00	
60					A 140	0.00	
61	A 3.20	G 4977	4916	30.2	M 150	1.00	
62	V 3.16	N 4773	4810	29.7	A 199	0.00	
70	V 3.20						
71	A 3.12	G 5176	5320		M 189	0.50	
71	A 3.12				M 190	1.00	
71	V 3.12						
71	V 3.10						
72	A 3.24	G 4760	4607	32.0		1.00	
72	A 3.24						
73	V 3.20	A 6340	6263				
73	V 3.20						
73b	V 3.23	A 6520	6359				
73b	V 3.22						
74	V 3.12	G 4272	4369				
74	V 3.14						
75	V 3.09	N 3763	3949		A 190	0.58	
75	V 3.08						
76	V 3.17	N 4871	4885				
77	A 3.19	G 4930	4895	31.0	A 200	0.90	
78	A 3.23			31.4	A 190		3.2 et 5,6(F)
78	A 3.23						
80	A 3.16	G 4600	4636	30.8	M 175		
81				31.6	A 178		
82							6.5
82							6.1
83c	V 3.19	N 4850	4815				42.9
83c	V 3.19						
83d	V 3.20	N 5000	4989	31.8	M 205	0.50	
83d	V 3.18					2.00	
83i	V 3.17	N 4920	4885	31.6	M 220	0.50	
83i	V 3.19					0.50	
84	V 3.24	G 5100	4936	30.2	A 155	0.50	
85				31.2	A 275		3.1
85				31.2	A 275		3.1
100	A 3.20	G 4990	4929	30.0	A 190	1.00	
100	A 3.20					1.00	
101	A 3.19	N 4760	4726	30.2	A 179	1.00	
102	A 3.11	A 4841	5000	30.0	M 190	0.00	
103	V 3.15	A 4830	4892	30.8	A 200	1.00	
103				30.6	A 185		
104	A 3.19	N 4810	4775	30.2	A 191	1.00	
105	A 3.19	N 4755	4721	30.3	A 200	1.00	
106	A 3.20	G 4950	4890	30.0	A 185	1.00	
107	A 3.20	N 5130	5067	30.2	A 191	0.00	
108	A 3.22	N 4870	4762	29.8	A 180	0.20	
109	A 3.21						

Labs	Specific Gravity (g/cm3)	Specific Surface (cm^2/g)	Corrected Surface (cm^2/g)	Normal concistency (%)	Initial Setting Time (min)	Soundness (mn)	Workability (s)
110		N 4963			M 195	0.50	
110					M 195	0.50	
111	A 3.19	N 4846	4811	30.0	A 206	0.75	
111	A 3.19			30.2	A 211	0.75	
112	V 3.16	N 4860	4898	29.0	A 145		
113	V 3.17	N 4700	4713	31.6	A 170	0.00	
114	V 3.15	N 4600	4705	30.2	A 192	0.00	
114	V 3.13			30.2	A 188		
114				30.2	M 190		
114				30.2	M 190		
115	A 3.20	A 4856	4797	29.9	A 183	0.30	
115	A 3.19			30.0	A 188	0.60	
116	A 3.18	N 4932	4921		A 168		
116					A 170		
117					M 240	.	
117					M 230	.	
118	A 3.18	A 4920	4909	30.6	A 195	1.00	
119	A 3.20	N 4780	4722	30.0	A 180	1.00	
120	A 3.02	N 4434	4779	29.5	A 192	0.00	
121	V 3.20	N 4452	4398	30.2	A 165	0.50	
121	V 3.20			30.0	A 160	0.50	
122	V 3.05	A 4595	4884	30.0	A 181	1.00	
123	V 3.14	N 4275	4287	29.7	A 171	1.00	
123	V 3.17			29.8	A 167	0.50	
124				32.3	A 232	0.00	
125	A 3.20	N 4583	4527	30.8	A 180	0.00	
126	A 3.17	N 4609	4622	31.6	A 200	1.40	
126						1.40	
127	V 3.14	G 4610	4692	30.4	M 160	1.00	
128	A 3.13	N 4984	5098	30.0	A 190		
129	V 3.18	N 4706	4696	30.4	A 179	0.25	
130	V 3.17	A 4591	4602	32.6	A 230	0.10	
131	V 3.22	G 5017	4931	30.3	A 190	0.50	
131	V 3.20	N 4850	4791	30.4	A 190	0.00	
131				30.4	M 185		
131				30.6	M 180		
132	V 3.20	A 4792	4722	31.1	A 205		
132	V 3.21			31.2	A 209		
133	V 3.14	A 4818	4904	30.8	M 174	0.30	
133				30.8	M 183	0.20	
134	A 3.18	L 4970	4959	30.6	A 194	0.28	
134				30.6	A 195	0.33	
134				30.5			
135	V 3.17	A 4850	4864	29.2	A 155	0.50	
136	A 3.15	4310	4365	25.9	M 150	1.00	
137	A 3.10	N 4624	4799	30.6	A 172	1.00	
137	A 3.10			30.6	A 180	0.50	
138	A 3.18	G 4688	4678	31.5	A 197	0.50	
138		N 4472	4462	31.5	A 197	0.50	
138				31.5			
138				31.5			
139	A 3.20	A 4776	4718	29.8	A 160	1.00	
139	A 3.21			29.8	M 170	1.10	
140	V 3.19	A 4780	4746	30.5	M 185	1.50	
141	V 3.21	A 4850	4767	31.0	A 185	1.00	
141					M 200		
142	V 3.19	A 4950	4914	31.0	M 185	0.60	
142	V 3.19			31.0	M 187	0.60	
143	A 3.20	N 4844	4792	28.6	A 142	0.05	
144	V 3.20	G 4822	4763	30.5	A 180	0.70	
145	V 3.20	A 4800	4741	31.0	A 185	1.00	
146	V 3.18	G 4806	4795	31.4	A 190	0.50	
148	V 3.17	G 4640	4688	32.0	A 160	0.14	
148	V 3.14						
149	V 3.18	A 5235	5224	31.0	A 190	0.00	
149				31.0		0.50	
150	A 3.20	G 4950	4890	30.5	A 199	0.50	
150	A 3.20			30.5	A 200	0.50	
150				30.6			
150				30.5			

Labs	Specific Gravity (g/cm3)	Specific Surface (cm^2/g)	Corrected Surface (cm^2/g)	Normal concistency (%)	Initial Setting Time (min)	Soundness (mn)	Workability (s)
151	A 3.19	A 4840	4805	29.1	A 207	0.75	
152	A 3.21			31.5	A 210	1.00	
152	A 3.22			31.5	A 215	0.50	
153	A 3.19	A 4840	4805	32.0	A 180	1.00	
153	V 3.20			32.0	M 190	1.00	
154	V 3.14	A 4690	4774	30.0	A 215	1.00	
154	V 3.14						
155	A 3.20	N 5000	4939	30.1	A 209	0.00	
155					M 222	0.00	
157	A 3.22	N 4871	4763	32.4	A 178	0.00	
157	A 3.22			32.6	A 180	1.00	
157				32.3	M 180		
158	A 3.20	A 4810	4762	32.0	M 200		
158				31.5			
158				32.2			
158				32.5			

Labs	Shrinkage 3d (µm/m)	Shrinkage 7d (µm/m)	Shrinkage 14d (µm/m)	Shrinkage 28d (µm/m)	Swelling 3d (µm/m)	Swelling 7d (µm/m)	Swelling 14d (µm/m)	Swelling 28d (µm/m)
4	104	277	495	651	12	13	2	15
7	165	342	525	721				
9	96	288	479	694	15	36	44	37
11	71	206	377	596				
13		229	456	623				123
15	96	258	425	546				
23	100	251	381	540				
71	108	285	452	610	6	13	48	50
72	138	296	475	660	35	31	29	69
73	94	307	521	675				
73a	160	282	550	694				
73b	106	279	539	684				
75	77	246	451	538	31	35	67	44
77	194	265	479	621	92	123	125	129
78	550	515	491	455				
81	171	350	623	777	42	100	98	71
83c	90	261	429	677	50	52	88	73
83i	146	319	515	713	25	19	54	46
84	144	292	477	631	54	63	86	117
100	91	239	368	584	91	98	106	98
102	73	250	344	417	63	188	167	42
150						142	342	973
153	193	370	570	753				
156	152	329	509	673				

Labs	Heat of Hydration 41h ($J.g^{-1}$)	Heat of Hydration 3d ($J.g^{-1}$)	Heat of Hydration 5d ($J.g^{-1}$)	Heat of Hydration 7d ($J.g^{-1}$)	Maximale Flux ($J.g^{-1}.h^{-1}$)	Age at maximale flux (h)
1	313					
2	349					
3	318					
4	326	331	331		28.5	8.0
8	333	368	379			
9	353	378	389			
10	320					
11	358	385	396	401		
12	367	384	391	365		
13	333	343	346			
14	325					
15	319	337	344		26.1	8.5
22	327					
26	327	340	341			
57	347					
71	340	349	353		28.0	10.0
71					28.0	10.0
71					28.0	10.0
72	308	320	326			
73	318	323	329		32.5	8.0
73b	310	316	323		34.4	8.0
77	365	383	390			
83d	321	323	323		29.2	9.0
83i	329	339	343		30.4	9.0
84	345	367	378			
100		288	322	341		
102	300					
103				342		
107				326		
111	343	355	360	365		
116	313	332	335			
119	184	258		320		
127	349	362	373	385		
128	318					
129	309	329	333	337		
131	348	384	401			
135	307	311	312			
140	299	314	321		27.2	8.7
140					27.4	9.1
148	331	345	349			
151	378	397	406	413	32.5	8.4
151					34.2	8.1
151					33.7	8.8
152	308					
153	337	389			23.5	8.4
153					23.6	8.4

Labs	Clinker (%)	Set regulator (%)	Minor additional constituents (%)	Minor additional constituents (%)	Mineralogy C3S (%)	Mineralogy C2S (%)	Mineralogy C3A (%)	Mineralogy C4AF (%)	Mineralogy free lime (%)	Mineralogy SO4Ca (%)
2					59.6	16.3	2.2	16.4	0.5	4.1
2a					60.8	17.0	1.8	12.4	0.0	2.8
3					62.7	16.3	1.0	14.6		
4					61.8	14.8	1.1	14.2	1.5	
5a	96.2	3.8	0.0	0.0	65.6	13.0	3.8	12.5	0.9	3.0
5a	96.2	3.8	0.0	0.0						
6					62.7	12.8	1.3	13.7	0.9	1.6
7					64.3	14.1	1.0	15.1	1.0	2.9
8	96.3	3.7			58.8	16.8	0.8	15.0		
9					61.4	16.6	2.5	14.7	0.5	0.8
10	95.5	4.5								
11					62.9		0.9	14.4		
15	96.0	3.8	0.3	0.0	61.3	15.3	3.1	14.8	2.9	1.4
15	95.3	3.7	0.0	0.0						
20					61.8	15.9	2.5	14.5	0.5	
26	95.0	4.0	1.0		56.2	18.5	1.5	14.5	1.4	
28					63.2	15.5	1.4	13.6	0.6	
30					63.1	13.6	1.0	14.6	1.2	3.0
54					64.1	14.2	2.6	14.6	0.9	2.6
55	96.7									
60	97.5				62.2	16.3	1.7	14.7	1.1	2.5
62	95.3	3.8	0.9		63.0	15.0	2.4	14.4	1.0	3.0
83a	96.1	3.9								
83a	96.2	3.8								
83e	96.4	3.6								
83e	96.2	3.8								
100	96.4	3.6	0.0	0.0	61.5	14.9	1.5	16.3	1.0	3.3
100	96.4	3.6	0.0	0.0						
102	94.9	3.7	0.0	1.4						
103					65.8	14.2	0.2	14.3	1.6	1.8
104					61.3	16.1	2.2	14.4	1.4	0.1
105					62.3	15.2	2.4	14.4	1.2	0.0
108	96.2	3.8	0.0	0.0						
109					64.6	13.2	0.9	14.2	1.4	3.4
112	95.6	3.4	1.0							
113	95.4	3.8	0.8							
114	96.5	3.5	0.0							
115					59.3	18.5	2.5	12.4	1.0	
120	97.4	2.6								
122					64.2	10.5	3.5	11.7	0.8	3.7
128	93.1	3.7	3.2		63.3	15.4	2.6	13.6	0.4	2.1
129							0.9			
130	93.8	3.8	2.4							
131	96.3	3.7			66.9	13.9	2.5	13.8	1.3	2.2
135	96.4	3.6			73.1	2.5	1.1	13.9		
137					61.8	14.7	2.3	14.4	1.1	
139	94.5	3.5	0.5							
139		4.1	0.5							
141	96.3	3.7			72.2	9.2	2.4	11.8	0.6	3.8
144	96.3	3.7								
145	96.2	3.8								
146	96.4	3.6	0.0	0.0						
148	96.3	3.8	0.0	0.0	64.8	13.2	2.8	15.2	0.5	1.9
149	96.2	3.8	0.0	0.0	63.1	14.7	2.6	13.7	0.9	1.5
150					61.9	11.9	1.1	14.4	1.0	
151					62.6	15.2	1.4	13.1	1.8	4.7
153	97.1	3.7	2.9				1.0	15.1		
153	97.0	3.7	3.0							
156					62.0	16.0	2.1	13.1	0.8	3.6
156					63.0	15.0	1.0	15.0		

Particle size distribution (opening sieve in µm and expression of results in %)

N° Labo	Method	1.25	2	3.15	4	5	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	90	100	125	160	200
1	Alpine													99.0									
2	Alpine														99.6	99.7	99.9	99.9	99.9	99.9	99.9	100.0	100.0
2a	Alpine														99.6	99.7	99.8	99.8	99.8	99.8	99.8	99.9	99.9
4	Laser	8.6	14.4	23.2	29.3	35.8	43.2	51.7	60.4	70.2	81.9	90.3	95.6	98.6	99.9	100.0							
6	Laser	6.1	11.1	18.4	24.5	31.1	38.8	47.4	56.1	50.3	76.6	85.9	93.2	98.0	99.8	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
7	Alpine																99.8	99.9	99.9	99.9	99.9	99.9	100.0
7	Laser	2.5	6.1	14.1	18.4	25.0	31.9	39.1	48.7	58.3	69.0	77.2	85.5	94.0	97.8	99.7	100.0						
9	Alpine														99.6	99.7	99.7	99.8					
9	Laser	14.8	20.2	26.5	29.8	34.7	39.7	44.9	53.1	61.4	70.5	75.2	80.0	84.9	90.0	94.7	99.7						
10	Alpine														99.6	99.7	99.8	99.8	99.8				
11	Laser	7.1	13.2	20.4	25.9	31.0	37.4	45.1	53.3	62.3	72.8	81.8	89.4	95.2	98.7	99.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0
12	Laser	11.0	16.0	23.5	28.8	34.4	40.7	47.7	54.6	62.2	71.6	81.0	90.1	96.8	99.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
13	Laser	12.3	17.6	25.4	30.4	36.1	42.6	49.9	57.3	65.2	74.5	82.8	90.2	95.8	99.1	99.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0
14	Alpine																						99.1
20	Laser	8.8	15.4	25.0	30.8	36.1	41.7	48.0	56.3	64.9	75.7	84.4	92.4	97.6	99.1	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
21	Laser	12.6	17.9	26.0	31.4	37.0	43.3	50.5	58.1	76.4	76.1	84.4	91.4	96.5	99.4	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
23	Alpine														99.0								
23	Laser	12.1	19.2	26.2	28.8	34.7	41.6	45.5	54.4	64.9	70.6	81.8	91.2	94.3	97.0	99.5	99.9	100.0	100.0	100.0	100.0	100.0	100.0
25	Laser	8.1	14.6	22.9	27.3	33.1	39.0	45.2	54.6	64.1	74.5	82.1	89.6	97.5	98.6	99.3	100.0	100.0	100.0	100.0	100.0	100.0	100.0
26	Alpine														99.5								
26	Laser							45.4	53.5	61.7	70.7	78.8	87.0	95.4									
28	Laser	9.6	14.8	22.5	27.1	31.4	36.4	42.8	50.8	60.4	71.7	81.6	90.0	96.0	99.2	99.9	100.0						
29	Alpine												98.4	99.0	99.8	99.8	99.8	99.9	99.9				
31	Laser	13.0	18.9	26.8	32.0	37.4	43.5	50.4	57.6	65.6	75.1	83.2	90.5	96.0	99.3								
32	Alpine														98.8	99.2	99.7	99.8	99.8				
32	Laser	19.1	24.7	31.6	36.8	42.9	50.0	57.9	64.0	70.4	80.4	91.2	97.5	99.7									
33	Laser	7.9	14.2	22.2	26.4	31.6	37.0	42.5	51.7	60.8	71.0	79.3	87.6	96.2	97.8	98.9	99.9	100.0	100.0	100.0	100.0	100.0	100.0
34	Laser	6.7	12.2	19.9	24.0	30.0	36.2	42.6	52.1	61.7	72.2	80.1	87.9	96.0	97.7	98.8	99.9	100.0	100.0				
35	Alpine														99.7	99.7	99.7	99.8	99.8				
35	Laser														95.2								
36	Alpine														99.6								
37	Alpine														99.7								
38	Alpine														99.6	99.7	99.8	99.9					
39	Alpine														99.6								
40	Alpine														99.3	99.5	99.7	99.9	99.9	99.9	99.9	99.9	
42	Alpine														99.6	99.7	99.8	99.9	99.9				
42	Laser												86.0										
43	Laser					33.8	41.1	48.6	55.7	64.0	73.1	81.4	86.9	92.5	98.4								
45	Alpine														99.6	99.7	99.7	99.8	99.8				
47	Laser	9.4	15.0	22.5	27.2	32.3	37.9	44.7	52.8	61.2	71.7	87.9	96.3	99.8									
49	Alpine														99.4	99.5	99.6	99.7	99.8				
50	Alpine																	99.6	99.7	99.9	99.9	99.9	99.9
50	Laser	13.4	19.3	26.8	30.7	35.4	40.3	45.3	53.2	61.1	69.8	77.2	84.5	92.2	95.8	98.1	99.3	99.7	99.9	100.0	100.0	100.0	100.0
51	Alpine														99.5	99.5	99.6	99.6	99.7	99.7	99.7	99.8	99.9
53	Alpine																99.8	99.9	99.9				
53	Laser	6.6	11.2	19.0	23.1	31.2	39.5	48.2	52.4	56.6	61.3	70.9	80.4	90.3	98.0	99.2	99.9	99.9	100.0	100.0	100.0	100.0	100.0
54	Alpine															99.6							
54	Laser	12.1	17.3	24.7	28.6	33.8	39.2	44.7	52.5	60.3	68.9	76.8	84.6	92.7	96.8	99.0	99.9	100.0	100.0	100.0	100.0	100.0	100.0
59	Alpine															99.6	99.7						
60	Laser	14.6	20.4	28.5	33.5	39.1	45.1	51.9	58.9	66.7	75.7	83.7	90.7	95.9	98.5	99.9							
61	Laser	11.8	19.3	27.0	31.4	36.0	41.7	48.7	56.3	64.9	75.1	83.9	91.3	96.3	99.1	99.9	100.0	100.0	100.0	100.0	100.0	100.0	
72	Laser	6.9	11.0	16.8	21.4	27.5	36.3	48.1	60.9	73.6	85.0	92.1	96.2	98.4	99.5	99.8	100.0	100.0	100.0	100.0	100.0	100.0	100.0
75	Laser	6.8	12.0	17.9	20.9	23.8	27.2	31.8	37.7	45.6	56.5	67.3	78.1	87.7	94.7	98.5	99.9	100.0	100.0	100.0	100.0	100.0	100.0
76	Alpine											92.9	95.8	98.9	99.6	99.8							
76	Laser	4.9	7.2	11.9	16.3	21.9	29.4	38.9	49.0	59.9	71.8	81.6	89.6	95.5	99.0	99.5							
77	Laser	9.6	15.3	23.5	28.7	34.1	40.1	46.9	54.1	62.1	71.8	80.4	98.0	94.0	97.7	99.4	99.9	100.0	100.0	100.0	100.0	100.0	100.0
78	Laser	13.7	19.4	27.5	32.8	38.4	44.9	52.5	60.3	68.8	78.3	86.4	93.0	97.6	99.8	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
83c	Alpine															99.4	99.7	99.8	99.8				
83i	Alpine															99.2	99.8	99.9	99.9				
83i	Laser	9.4	15.7	23.5	28.1	33.0	39.2	47.2	56.3	66.8	78.3	87.2	93.8	97.5	99.2	99.8	100.0	100.0	100.0	100.0	100.0	100.0	100.0
100	Alpine														99.6	99.7	99.7	99.8	99.8	99.8	99.8	99.9	99.9
100	Laser	8.7	14.6	22.8	28.2	33.9	40.3	47.7	55.3	63.6	73.4	82.1	89.6	95.4	98.7	99.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0
101	Alpine											93.5	95.1	96.8	98.5	99.5	99.7	99.8	99.8				
101	Laser	16.1	19.9	28.8	33.5	37.9	43.6	49.5	55.0	63.0	71.9	80.0	84.8	89.9	95.1	100.0	100.0	100.0	100.0	100.0			
102	Laser	4.7	7.1	11.7	16.0	21.4	28.6	37.7	47.5	58.0	69.7	79.6	88.1	94.5	98.6	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
103	Laser	8.1	13.0	19.5	24.3	29.4	36.3	45.2	55.0	65.3	76.5	85.3	91.8	96.0	98.5	99.6	99.9	100.0	100.0	100.0	100.0	100.0	
104	Alpine																		99.5				
104	Laser	.	13.0	20.8	25.6	30.6	36.3	43.2	50.6	59.7	71.0	81.8	91.2	97.2	100.0								
105	Laser	14.4	19.4	27.7	32.5	37.0	42.8	48.8	55.3	57.0	48.4	81.2	90.7	97.1	99.5								
107	Laser	6.2	16.5	19.2	23.4	28.9	36.6	42.7	50.6	61.2	69.5	79.2	89.2	94.2	98.2	99.8	100.0	100.0	100.0	100.0	100.0	100.0	100.0
108	Laser	7.4	14.3	22.0	26.7	31.6	37.2	44.0	51.4	59.9	70.5	80.3	88.9	94.9	98.5	99.8	100.0	100.0	100.0	100.0	100.0	100.0	100.0
109	Alpine															99.7	99.9	99.9	99.9	99.9	100.0	100.0	100.0
109	Laser	6.1	11.9	20.2	25.6	31.3	37.7	45.0	52.6	61.0	70.9	79.8	87.7	94.0	98.0	99.6	100.0	100.0	100.0	100.0	100.0	100.0	100.0
112	Alpine																99.6	99.7	99.8	99.8	99.8	99.9	99.9
113	Alpine															99.6	99.8	99.8	99.9	99.9	99.9	99.9	99.9
114	Alpine															99.5	99.7	99.8	99.8	99.8	99.8	99.9	99.9

N° Labo	Method	1.25	2	3.15	4	5	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	90	100	125	160	200
115	Laser		13.9	22.2	27.1	32.1	37.8	44.5	51.9	60.8	72.0	82.2	90.9	96.5	99.4	100.0							
119	Laser	2.0	6.6	13.7	18.5	23.9	30.5	38.5	47.4	57.3	68.8	78.8	87.4	94.1	98.4	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
120	Alpine												95.8	98.8	99.3	99.5	99.8	99.9	99.9				
121	Alpine														99.4	99.7	99.8	99.9	100.0	100.0	100.0	100.0	100.0
121	Laser	3.3	8.2	16.1	21.4	27.5	34.2	42.3	51.4	60.5	71.4	80.2	88.5	94.9	97.9	99.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0
122	Laser	8.4	13.9	21.6	26.6	31.7	37.6	44.4	51.9	60.4	70.6	79.7	87.6	93.9	97.8	99.5	100.0	100.0	100.0	100.0	100.0	100.0	100.0
123	Alpine															100.0							
125	Laser	7.0	13.2	21.6	27.1	32.8	39.3	46.8	54.7	63.6	74.4	84.0	92.3	97.8	99.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
126	Laser	12.0	18.9	28.0	33.2	38.5	44.3	51.0	58.2	66.6	76.8	85.8	93.2	98.0	99.8	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
128	Laser	8.1	12.3	19.1	24.1	29.6	36.2	44.0	52.1	61.1	71.8	81.3	89.6	95.9	99.2	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
129	Alpine														99.4	99.7	99.8	99.8	99.8	99.8	99.8		
130	Laser	8.7	14.1	22.4	28.2	34.4	41.6	49.1	56.9	65.3	74.8	83.1	90.2	95.6	99.1	100.0	100.0	100.0	100.0	100.0	100.0		
131	Alpine															99.7	99.8	99.9	100.0	100.0	100.0		
131	Laser	8.5	16.7	26.7	32.0	37.9	44.0	50.8	58.2	65.5	75.2	82.9	90.6	98.5	100.0	100.0							
132	Alpine														99.4	99.6	99.7	99.8	99.9				
132	Laser	5.7	9.5	16.2	21.3	27.0	34.0	42.2	51.0	60.6	71.6	81.1	89.1	95.2	98.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
134	Laser					29.3	36.5	43.9	50.9	60.2	70.4	79.7	86.9	94.4	97.6	99.4	99.9	100.0					
135	Laser	8.0	13.0	19.0	23.0	28.5	34.0	41.0	48.0	57.0	69.7	80.0	87.8	95.0	99.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
136	Alpine															92.5							
136	Laser	9.0	15.3	22.2	26.0	29.7	33.8	38.3	42.9	48.2	54.9	61.5	68.7	76.2	83.4	89.0	93.7	97.2	98.4	99.1	100.0	100.0	
137	Alpine														99.5	99.6	99.8	99.8	99.8				
139	Laser	5.4	7.4	13.2	18.3	25.7	35.8	47.9	59.2	77.3	92.8	93.4	94.3	95.8	97.4	98.9	99.7	99.3	99.9	100.0			
140	Laser		9.7	22.3	28.0	33.0	38.8	46.3	54.4	63.5	74.5	84.2	92.2	97.2	99.9	99.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0
141	Alpine														99.6	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8
141	Laser	2.1	2.5	4.3	6.9	11.5	19.7	32.1	47.0	63.1	78.8	89.1	95.0	98.1	99.4	99.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0
142	Alpine															98.0	98.8	99.5	99.9				
143	Laser			21.6	29.2	36.2	43.5	51.0	58.0	65.0	72.8	79.8	86.8	94.1	98.1	99.4	100.0	100.0	100.0	100.0	100.0	100.0	100.0
144	Alpine																		99.8				
145	Alpine														99.2	99.3	99.5	99.7	99.8				
148	Alpine														99.4	99.6	99.7	99.8	99.8				
148	Laser		13.9	20.2	24.3	29.0	34.8	42.2	50.8	60.6	72.4	82.5	90.8	96.8	99.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
149	Alpine														99.2	99.5	99.6	99.7	99.8	99.8	99.8	99.9	99.9
150	Laser	10.6	16.0	22.1	25.3	29.5	35.9	44.8	55.0	63.4	73.5	86.0	91.8	95.1	98.5	99.1	99.3	99.7	99.9	100.0			
151	Alpine												97.7	99.1	99.4	99.6	99.8	99.9	99.9				
151	Laser	8.0	11.9	18.7	23.8	29.5	36.4	44.6	52.9	61.4	71.2	80.4	88.6	94.5	97.7	99.1	99.7	100.0	100.0	100.0	100.0	100.0	100.0
154	Alpine															99.5							
155	Laser	9.4	15.0	23.0	28.6	34.7	41.6	49.5	57.8	66.6	76.7	85.6	92.7	97.0	99.0	99.8	100.0	100.0	100.0	100.0	100.0	100.0	100.0
156	Laser	12.5	21.1	30.3	35.7	41.3	47.8	55.1	62.4	70.0	78.9	86.8	93.5	97.8	99.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
157	Laser	7.5	13.2	20.6	25.7	31.1	37.6	45.1	52.9	61.3	71.1	79.6	87.1	93.0	96.7	98.3	98.8	98.8	98.8	98.8	98.8	98.8	98.8
158	Alpine													99.0									
158	Laser	7.0	11.5			28.5			50.8			79.6			98.7			100.0	100.0	100.0	100.0	100.0	100.0

Labs	Mass on demoulding (g)	Bending 1d (MPa)	Bending 2d (MPa)	Bending 7d (MPa)	Bending 28d (MPa)	Compressive 1d (MPa)	Compressive 2d (MPa)	Compressive 7d (MPa)	Compressive 28d (MPa)
1	584.0					A 18.4	A 30.2	A 49.5	A 64.2
2	603.0					A 19.5	A 32.2	A 48.1	A 62.9
2a	604.1					A 21.1	A 29.4	A 49.7	A 65.2
3						A 19.0	A 30.5	A 49.5	A 62.7
4	584.0	4.0	5.8	7.3	8.4	A 19.1	A 31.9	A 51.6	A 64.4
5a	584.5					A 20.0	A 29.9	A 49.2	A 61.6
5a						D 19.1	D 31.2	D 50.3	D 66.3
6						A 18.9	A 32.3	A 52.2	A 64.5
7	587.7	4.2	5.7	7.4	7.9	A 20.2	A 32.3	A 52.4	A 66.6
8	590.3	4.5	6.2	7.5	7.7	A 20.8	A 34.2	A 53.6	A 67.3
9	586.7					A 19.1	A 31.8	A 51.9	A 66.1
10	585.4	3.8	5.7	7.2	7.5	A 18.7	A 31.2	A 51.7	A 65.0
11	578.4	4.2	5.6	7.7	8.0	A 19.0	A 29.5	A 49.4	A 63.8
12		3.9	5.8	7.6	7.9	A 17.4	A 28.9	A 46.7	A 62.2
12						D 17.9	D 30.3	D 50.7	D 64.6
13	582.6	3.6	6.0	7.6	8.4	A 21.4	A 32.8	A 50.1	A 59.5
14						A 17.5	A 28.7	A 47.7	A 59.5
15	576.8	4.1	5.7	7.6	8.6	D 17.8	D 31.5	D 50.6	D 65.9
15						D 17.8	D 30.3	D 51.4	D 65.8
20	579.4					A 19.5	A 31.8	A 49.1	A 61.4
21	586.2					A 19.2	A 31.1	A 50.2	A 62.8
22	585.8					A 19.3	A 30.6	A 47.9	A 59.7
22a						A 17.7	A 30.3	A 43.6	A 59.4
23	581.0					A 20.5	A 32.4	A 50.3	A 65.5
25	590.0					D 20.2	D 32.1	D 52.4	D 65.4
26	584.0						A 30.9		A 61.7
28	576.8					A 19.5	A 30.8	A 47.9	A 61.6
29	589.0					A 18.6	A 29.5	A 49.4	A 62.5
30	591.0					A 20.3	A 32.5	A 50.2	A 63.3
31	581.5					A 18.9	A 30.6	A 49.0	A 60.6
32	591.0					A 18.3	A 29.5	A 50.1	A 64.2
33	587.2					A 18.8	A 31.2	A 50.0	A 63.1
34	588.0					A 18.7	A 31.9	A 51.9	A 66.0
35	585.5					A 20.5	A 32.5	A 50.8	A 65.8
36	586.0					A 20.3	A 32.3	A 52.1	A 66.7
37						A 19.3	A 32.0	A 51.8	A 66.6
38	592.5					A 21.7	A 33.9	A 53.7	A 66.2
39	578.3					A 19.0	A 32.9	A 51.8	A 63.9
40	586.0						A 31.1	A 51.9	A 63.8
41	585.0					A 19.1	A 32.5	A 49.7	A 61.0
42	592.0					A 19.7	A 32.3	A 52.9	A 67.6
43	594.1					A 20.5	A 31.9	A 51.7	A 66.4
44	589.0					A 18.9	A 31.4	A 49.2	A 66.0
45	589.6					A 20.7	A 32.6	A 52.5	A 66.7
46							A 30.1	A 51.0	A 65.5
47	587.0					A 19.4	A 29.1	A 50.0	A 66.1
48	590.7					A 19.4	A 31.1	A 51.5	A 63.3
49	581.0					A 18.5	A 30.5	A 51.9	A 63.6
50	586.6					A 18.9	A 30.4	A 49.7	A 63.0
51	579.2					A 19.8	A 31.3	A 49.1	A 63.7
52	587.6					A 20.0	A 32.3	A 51.4	A 66.0
54	589.5					A 19.8	A 32.5	A 51.9	A 66.5
55	579.7	4.2	5.3	7.2	8.1	A 16.0	A 29.0	A 46.0	A 62.2
56						A 23.5	A 35.3	A 52.2	A 69.0
57	586.0						A 31.8	A 50.8	A 66.0
59	590.0						A 31.6	A 51.9	A 66.8
60	587.2					A 20.0	A 33.4	A 53.5	A 66.7
61	576.1					A 19.6	A 30.8	A 49.4	A 64.9
62	573.9					D 18.2	D 30.2	D 50.3	D 63.9
71	586.0	4.2	5.7	7.9	8.5	A 19.2	A 30.3	A 49.5	A 61.8
72	590.0	4.6	6.2	7.9	8.2	A 21.1	A 33.1	A 53.6	A 65.9
73	584.1					A 18.6	A 30.5	A 47.3	A 58.5
73a	578.6					A 18.2	A 27.9	A 47.0	A 56.1
73b	585.4					A 19.1	A 31.7	A 47.4	A 60.7
74	586.3	4.1	5.5	6.5	7.8	A 20.2	A 30.9	A 51.1	A 63.3
75	572.3	4.4	5.4	5.9	7.2	A 19.7	A 30.0	A 45.8	A 58.7
77	592.8	4.2	5.7	8.5	8.7	A 19.9	A 31.7	A 50.3	A 65.0

Labs	Mass on demoulding (g)	Bending 1d (MPa)	Bending 2d (MPa)	Bending 7d (MPa)	Bending 28d (MPa)	Compressive 1d (MPa)	Compressive 2d (MPa)	Compressive 7d (MPa)	Compressive 28d (MPa)
78	587.6	4.4	6.0	6.9	8.2	A 22.9	A 30.7	A 50.0	A 67.4
79		3.7	4.7	6.4	8.1	A 18.6	A 27.3	A 49.1	A 65.6
80		5.2	6.0	8.0	8.5	A 19.6	A 30.5	A 49.7	A 64.3
81	588.6	4.5	6.5	7.6	9.9	A 19.8	A 32.5	A 50.9	A 65.1
82	586.8	5.5		8.0	8.1	A 23.7		A 44.1	A 55.6
83c	580.3	4.5	5.6	7.6	8.1	A 19.5	A 31.8	A 50.4	A 66.7
83g	577.8	4.6	6.4	7.7	8.2	A 19.7	A 32.1	A 50.0	A 62.8
83h	575.6	4.3	5.9	7.5	8.3	A 19.6	A 31.3	A 49.1	A 64.7
83i	581.0	4.2	5.5	7.3	8.4	A 19.1	A 31.9	A 50.0	A 64.7
84	588.0	4.8	6.3	7.7	8.7	A 21.3	A 34.1	A 53.9	A 69.6
85		5.2	5.1	6.9	7.7	A 18.4	A 28.8	A 38.9	A 41.8
100	585.0	4.5	6.0	7.8	8.4	D 19.8	D 31.4	D 51.1	D 65.4
101	587.0	4.3	5.6	7.5	8.5	A 20.0	A 31.4	A 51.0	A 64.7
101						D 18.2	D 31.4	D 51.6	D 66.0
102	591.7	4.6	6.5	8.1	8.6	A 19.5	A 30.5	A 49.3	A 62.1
102						D 18.3	D 30.9	D 50.0	D 64.9
103	581.4	4.1	5.4	7.1	8.7	A 19.8	A 31.7	A 51.7	A 66.8
104	586.0						A 30.3	A 48.3	A 60.0
105	576.2					A 20.2	A 31.3	A 49.7	A 63.1
106	590.8	4.2	5.8	7.4	8.3	D 19.8	D 29.6	D 48.1	D 62.0
107	579.0	4.5	6.2	8.2	8.4	A 19.0	A 32.5	A 51.9	A 68.1
107						D 19.7	D 33.2	D 54.1	D 69.0
108	587.9					A 18.5	A 30.7	A 49.7	A 66.4
108						D 19.0	D 30.9	D 52.2	D 66.6
110						A 19.3	A 30.5	A 48.3	A 60.8
110						D 19.4	D 30.9	D 48.3	D 62.8
111	574.5	4.8	6.4	7.6	8.4	A 19.2	A 30.7	A 48.9	A 61.2
112						D 18.6	D 31.2	D 51.2	D 65.4
113	601.2					A 17.5	A 30.2	A 51.6	A 65.9
114	580.8					A 18.4	A 29.2	A 49.6	A 64.2
115	586.5					A 20.3	A 30.5	A 49.2	A 62.8
116						A 19.4	A 30.5	A 48.1	A 60.5
117	590.1						A 31.6	A 51.6	A 66.4
117a	576.4						A 30.3		A 61.8
118						A 19.0	A 29.8	A 47.3	A 62.5
118						D 18.9	D 30.4	D 49.4	D 64.0
119		4.0	5.4	7.1	7.6	A 19.7	A 31.6	A 51.2	A 65.4
120	581.4					A 20.8	A 31.2	A 49.9	A 65.4
120						D 19.4	D 30.9	D 48.0	D 63.6
121	581.8					A 19.0	A 31.3	A 49.9	A 63.7
121						D 19.4	D 30.6	D 49.8	D 66.5
122	579.9	5.0	6.8	8.2	9.0	D 20.4	D 31.4	D 49.1	D 64.1
123							A 32.3		A 62.0
124							A 30.7	A 46.8	A 59.1
125	583.1	4.6	5.7	7.3	8.1	A 20.6	A 31.0	A 47.7	A 63.7
125						D 20.2	D 29.8	D 50.2	D 65.2
126	591.8	4.6	5.9	7.4	7.9	A 19.7	A 34.5	A 43.8	A 64.0
126a	591.4	4.7	6.4	8.0	8.4	A 18.2	A 35.4	A 56.5	A 69.4
127						A 19.4	A 31.1	A 51.3	A 63.7
128	589.0					A 19.7	A 31.2	A 51.5	A 63.4
128						D 18.1	D 29.3	D 48.6	D 61.4
129	592.8	4.5	6.4	7.7	9.2	A 18.4	A 30.4	A 48.2	A 63.0
130	585.4	4.2	5.6	8.0	9.0	A 19.6	A 30.2	A 52.0	A 63.6
130						D 20.0	D 31.1	D 51.9	D 67.1
131	582.5	4.4	6.4	8.0	9.0	A 19.6	A 30.5	A 47.4	A 61.7
131						D 19.9	D 32.0	D 52.3	D 68.9
132	574.3					A 18.5	A 29.5	A 47.7	A 61.0
132						D 18.2	D 30.1	D 49.5	D 62.7
133	584.7		5.9	7.8	8.5		A 30.0	A 48.2	A 61.2
134	584.4					A 20.2	A 32.4	A 51.4	A 64.6
135	582.6	3.7	5.5	6.7	7.7	A 20.5	A 32.1	A 50.5	A 64.0
136	566.5	3.8	5.4	7.5	8.6	A 16.7	A 29.6	A 46.3	A 60.5
136						D 16.7	D 30.5	D 49.7	D 63.3
137	579.7					A 18.6	A 29.9	A 47.7	A 60.4
138	601.8					A 19.8	A 29.5	A 49.1	A 62.0
139	593.2	4.7	6.2	7.8	7.9	A 19.9	A 30.7	A 51.0	A 65.8
139						D 20.8	D 32.2	D 54.6	D 64.5

Labs	Mass on demoulding (g)	Bending 1d (MPa)	Bending 2d (MPa)	Bending 7d (MPa)	Bending 28d (MPa)	Compressive 1d (MPa)	Compressive 2d (MPa)	Compressive 7d (MPa)	Compressive 28d (MPa)
140	588.8	5.0	5.9	7.8	8.8	A 20.3	A 31.0	A 50.5	A 67.3
140						D 20.1	D 31.0	D 52.9	D 64.7
141	579.7	4.8	6.2	8.3	8.8	A 19.4	A 31.0	A 49.8	A 63.4
142	589.5					A 19.9	A 32.0	A 51.6	A 65.1
143	577.0					A 19.1	A 30.6	A 46.1	A 62.0
143							D 28.9		D 63.7
144	579.9	4.2	5.6	7.2	8.0	A 18.9	A 30.9	A 49.3	A 64.1
145	581.3	4.5	5.9	7.8	8.5	A 19.3	A 31.8	A 49.3	A 63.0
146	579.8	4.4	5.9	7.1	8.0	A 20.1	A 32.0	A 50.1	A 63.8
148	576.2	4.3	6.2	7.4	8.6	A 20.3	A 32.8	A 48.4	A 65.5
149	586.9	4.1	6.0	7.8	7.7	A 20.7	A 32.3	A 50.5	A 62.9
150	586.7					A 20.3	A 31.5	A 49.6	A 64.0
150						D 21.9	D 31.7	D 51.6	D 65.5
151	585.3	4.2	5.6	7.5	8.2	A 18.1	A 30.2	A 49.3	A 64.3
152						D 22.4	D 34.1	D 50.3	D 67.6
153			5.8		7.8		D 30.1		D 63.9
153a		3.9	5.8	7.2	8.2	D 18.3	D 29.9	D 49.4	D 64.4
153b		4.2	5.6	7.0	8.3	A 19.0	A 30.9	A 48.3	A 62.5
154						A 19.5	A 31.2	A 49.0	A 63.5
155	576.9	4.4	5.7	6.5	8.6	A 19.2	A 30.3	A 38.6	A 64.9
156	580.8	4.2	5.5	7.8	8.6	A 18.4	A 31.7	A 50.1	A 62.1
156						D 19.5		D 55.0	D 65.6
157	582.5	3.7	5.6	6.9	7.9	A 17.8	A 30.1	A 50.6	A 63.0
158	575.5					A 21.8	A 31.1	A 48.2	A 60.3
158						D 20.7	D 31.0	D 49.6	D 64.5

Flyleaf photo caption:

Photo: Construction of 106 housing units in Massy (Photographer: Laurent Thion)

Owner: Vinci real estate

The architects: MP&A Agency

Specificity of concrete: Self-placing concrete, tinted in the mass, wainscot opacifying white