Table 1 - The 27 products in the family of common cements

Main types	Notation of the 27 products (types of common cement)		Composition (percentage by mass [a])											
			Main constituents											Minor additional constituents
			Clinker	Blast-furnace slag	Silica fume	Pozzolana		Fly ash		Burnt shale	Limestone			
						natural	natural calcined	siliceous	calca reous					
			K	S	D[b]	P	Q	V	W	T	L	LL		
CEM I	Portland cement	CEM I	95-100	-	-	-	-	-	-	-	-	-		0 to 5
CEM II	Portland-slag cement	CEM II/A-S	80 to 94	6 to 20	-	-	-	-	-	-	-	-		0 to 5
		CEM II/B-S	65 to 79	21 to 35	-	-	-	-	-	-	-	-		0 to 5
	Portland-silica fume cement	CEM II/A-D	90 to 94	-	6 to 10	-	-	-	-	-	-	-		0 to 5
	Portland-pozzolana cement	CEM II/A-P	80 to 94	-	-	6 to 20	-	-	-	-	-	-		0 to 5
		CEM II/B-P	65 to 79	-	-	21 to 35	-	-	-	-	-	-		0 to 5
		CEM II/A-Q	80 to 94	-	-	-	6 to 20	-	-	-	-	-		0 to 5
		CEM II/B-Q	65 to 79	-	-	-	21 to 35	-	-	-	-	-		0 to 5
	Portland-fly ash cement	CEM II/A-V	80 to 94	-	-	-	-	6 to 20	-	-	-	-		0 to 5
		CEM II/B-V	65 to 79	-	-	-	-	21 to 35	-	-	-	-		0 to 5
		CEM II/A-W	80 to 94	-	-	-	-	-	6 to 20	-	-	-		0 to 5
		CEM II/B-W	65 to 79	-	-	-	-	-	21 to 35	-	-	-		0 to 5
	Portland-burnt shale cement	CEM II/A-T	80 to 94	-	-	-	-	-	-	6 to 20	-	-		0 to 5
		CEM II/B-T	65 to 79	-	-	-	-	-	-	21 to 35	-	-		0 to 5
	Portland-limestone cement	CEM II/A-L	80 to 94	-	-	-	-	-	-	-	6 to 20	-		0 to 5
		CEM II/B-L	65 to 79	-	-	-	-	-	-	-	21 to35	-		0 to 5
		CEM II/A-LL	80 to 94	-	-	-	-	-		-	-	6 to 20		0 to 5
		CEM II/B-LL	65 to 79	-	-	-	-	-			-	21 to 35		0 to 5
	Portland-composite cement [c]	CEM II/A-M	80 to 94	<-------- 6 to 20 -------->										0 to 5
		CEM II/B-M	65 to 79	<-------- 21 to 35 -------->										0 to 5
CEM III	Blastfurnace cement	CEM III/A	35 to 64	36 to 65	-	-	-	-	-	-	-	-		0 to 5
		CEM III/B	20 to 34	66 to 80	-	-	-	-	-	-	-	-		0 to 5
		CEM III/C	5 to 19	81 to 95	-	-	-	-	-	-	-	-		0 to 5
CEM IV	Pozzolanic cement[c]	CEM IV/A	65 to 89	-	<-------- 11 to 35 -------->						-	-		0 to 5
		CEM IV/B	45 to 64	-	<-------- 36 to 55 -------->						-	-		0 to 5
CEM V	Composite Cement [c]	CEM V/A	40 to 64	18 to 30	-	<---- 18 to 30 ---->		-	-	-	-	-		0 to 5
		CEM V/B	20 to 38	31 to 50	-	<---- 31 to 50 ---->		-	-	-	-	-		0 to 5

[a] The values in the table refer to the sum of the main and minor additional constituents

[b] The proportion of silica fume is limited to 10 %.

[c] In Portland-composite cements CEM II/A-M and CEM II/B-M, in Pozzolanic cements CEM IV/A and CEM IV/B and in composite cements CEM V/A and CEM V/B the main constituents other than clinker shall be declared by designation of the cement (for example see clause 8).

7 Mechanical, physical, chemical and durability requirements

7.1 Mechanical requirements

7.1.1 Standard strength

The standard strength of cement is the compressive strength determined in accordance with ES 1176 - 1 at 28 days and shall conform to the requirements in Table 2.

Three classes of standard strength are included: class 32,5 class 42,5 and class 52,5

(see Table 2).

7.1.2 Early strength

The early strength of cement is the compressive strength determined in accordance with ES 1176 - 2 at either 2 days or 7 days and shall conform to the requirements in Table 2.

Two classes of early strength are included for each class of standard strength, a class with ordinary early strength, indicated by N, and a class with high early strength, indicated by R

(see Table 2).

Table 2 — Mechanical and physical requirements given as characteristic values

Strength Class	Compressive strength MPa				Initial setting time min	Soundness (expansion) mm
	Early strength		Standard strength			
	2 days	7 days	28 days			
32,5N	-	= 16, 0	= 32,5	= 52.5	= 75	= 10
32,5R	= 10, 0					
42,5N	= 10,0		= 42, 5	= 62.5	= 60	
42,5R	= 20, 0					
52,5N	= 20, 0		= 52, 5		= 45	
52,5R	= 30, 0					

7.2 Physical requirements

7.2.1 Initial setting time

The initial setting time, determined in accordance with ES 1176 - 3, shall conform to the requirements in Table 2.

7.2.2 Soundness

The expansion, determined in accordance with ES 1176 - 3, shall conform to the requirement in Table 2.

7.3 Chemical requirements

The properties of the cements of the cement type and strength class shown in columns 3 and 4 respectively of Table 3 shall conform to the requirements listed in column 5 of this table when tested in accordance with the standard referred to in column 2.

NOTE: Some European countries have additional requirements for the content of water-soluble hexavalent chromium (see informative annex A).

7.4 Durability requirements

In many applications, particularly in severe environmental conditions, the choice of cement has an influence on the durability of concrete, mortar and grouts, e.g. frost resistance, chemical resistance and protection of reinforcement. The choice of cement, from ES 1177 - 1, particularly as regards type and strength class for different applications and exposure classes shall follow the appropriate standards and/or regulations for concrete or mortar valid in the place of use.

Table 3 - Chemical requirements given as characteristic values

1	2	3	4	5
Property	Test reference	Cement type	Strength class	Requirements a)
Loss on ignition	ES 1176 -2	CEM I CEM III	all	< 5,0 %
Insoluble residue	ES 1176 - 2 [b]	CEM I CEM III	all	< 5,0
Sulfate content (as SO_3)	ES 1176 - 2	CEM I CEM II [d]	32,5 N 32,5 R 42,5 N	< 3,5
		CEM IV CEM V	42,5 R 52,5 N 52,5 R	< 4,0
		CEM III [c]	all	
Chloride content	ES 1176 - 6	all e)	all	< 0,10 % f)
Pozzolanicity	ES 1176 - 5	CEM IV	all	Satisfies the test

a) Requirements are given as percentage by mass of the final cement.

b) Determination of residue insoluble in hydrochloric acid and sodium carbonate.

c) Cement type CEM II/B-T may contain up to 4,5 % sulfate for all strength classes.

d) Cement type CEM II/C may contain up to 4,5 % sulfate.

e) Cement type CEM III may contain more than 0,10 % chloride but in that case the maximum chloride content shall be stated on the packaging and/or the delivery note.

f) For pre-stressing applications cements may be produced according to a lower requirement. If so, the value of 0,10 % shall be replaced by this lower value which shall be stated in the delivery note.

8 Standard designation

CEM cements shall be identified by at least the notation of the cement type as specified in Table 1 and the figures 32,5, 42,5 or 52,5 indicating the strength class (see 7.1). In order to indicate the early strength class the letter N or the letter R shall be added as appropriate (see 7.1).

EXAMPLE 1:

Portland cement conforming to ES 1177-1 of strength class 42,5 with a high early strength is identified by:

Portland cement ES 1177-1 - CEM I 42,5 R

EXAMPLE 2:

Portland-limestone cement containing between 6 % and 20 % by mass of limestone with a TOC content not exceeding 0,50 % by mass (L) of strength class 32,5 with an ordinary early strength is identified by:

Portland-limestone cement ES 1177-1- CEM II/A-L 32,5 N

EXAMPLE 3:

Portland-composite cement containing in total a quantity of granulated blastfurnace slag (S), siliceous fly ash (V) and limestone (L) of between 6 % and 20 % by mass and of strength class 32,5 with a high early strength is identified by:

Portland-composite cement ES 1177-1 - CEM II/A-M (S-V-L) 32,5 R

EXAMPLE 4:

Composite cement containing between 18 % and 30 % by mass of granulated blastfurnace slag

(S) and between 18 % and 30 % by mass of siliceous fly ash (V) of strength class 32,5 with an

ordinary early strength is identified by:

Composite cement ES 1177-1 - CEM V/A (S -V) 32, 5 N

9 Conformity criteria

9.1 General requirements

Conformity of the 27 products to ES 1177-1 shall be continually evaluated on the basis of testing of spot samples. The properties, test methods and the minimum testing frequencies for the autocontrol testing by the manufacturer are specified in Table 4. Concerning testing frequencies for cement not being dispatched continuously and other details, see ES 1177 - 2.

For certification of conformity by an approved certification body, conformity of cement with ES 1177-1 shall be evaluated in accordance with ES 1177 -2.

NOTE:ES 1177-1 does not deal with acceptance inspection at delivery.

Table 4 - Properties, test methods and minimum testing frequencies for the autocontrol testing by the manufacturer, and the statistical assessment procedure

Property	Cements to be tested	Test method [a), b)]	Autocontrol testing			
			Minimum testing frequency		Statistical assessment procedure	
			Routine situation	Initial period for a new type of cement	Inspection by	
					Variables [e)]	Attributes
1	2	3	4	5	6	7
Early strength Standard strength	All	EN 196-1	2/week	4/week	x	–
Initial setting time	All	EN 196-3	2/week	4/week	–	x [f)]
Soundness (Expansion)	All	EN 196-3	1/week	4/week	–	x
Loss on ignition	CEM I, CEM II	EN 196-2	2/month [c)]	1/week	–	x [f)]
Insoluble residue	CEM I, CEM II	EN 196-2	2/month [c)]	1/week	–	x [f)]
Sulfate content	All	EN 196-2	2/week	4/week	–	x [f)]
Chloride content	All	EN 196-21	2/month [c)]	1/week	–	x [f)]
Pozzolanicity	CEM IV	EN 196-5	2/month	1/week	–	x
Composition	All	- [d)]	1/month	1/week	–	

a) Where allowed in the relevant part of EN 196, other methods than those indicated may be used provided they give results correlated and equivalent to those obtained with the reference method.
b) The methods used to take and prepare samples shall be in accordance with EN 196-7.
c) When none of the test results within a period of 12 months exceeds 50 % of the characteristic value the frequency may be reduced to one per month.
d) Appropriate test method chosen by the manufacturer.
e) If the data are not normally distributed then the method of assessment may be decided on a case by case basis.
f) If the number of samples is at least one per week during the control period, the assessment may be made by variables.

9.2 Conformity criteria for mechanical, physical and chemical properties and evation procedure

9.2.1 General

Conformity of cement with the requirements for mechanical, physical and chemical properties in ES 1177-1 is assumed if the conformity criteria specified in 9.2.2 and 9.2.3 are met. Conformity shall be evaluated on the basis of continual sampling using spot samples taken at the point of release and on the basis of the test results obtained on all autocontrol samples taken during the control period.

9.2.2 Statistical conformity criteria

9.2.2.1 General

Conformity shall be formulated in terms of a statistical criterion based on:

- the specified characteristic values for mechanical, physical and chemical properties as given in 7.1, 7.2, and 7.3 of ES 1177-1;
- the percentile P_k, on which the specified characteristic value is based, as given in Table 5;