— type of admixture and addition, if specified;

— type and content of fibres or performance class of fibre reinforced concrete, if specified;

— special properties, if required;

— D_{max};

— in case of lightweight or heavy-weight concrete: density class or target density;

b) for prescribed concrete:

— details of the composition, e.g. cement content, and, if required, type of admixture;

— either target w/c ratio, or consistence in terms of class or target value, as specified;

— D_{max};

— type and content of fibres, if specified.

(3) In the case of standardized prescribed concrete, the information to be given shall follow the provisions of the relevant standard.

7.4 Delivery information for site-mixed concrete

(1) Appropriate information as required in 7.3 for the delivery ticket is also relevant for site-mixed concrete where the site is large or several types of concrete are involved or where the party producing the concrete is different from the party who is responsible for placing the concrete.

7.5 Mix adjustments after the main mixing process and prior to discharge

(1) In general, the adjustment of the mix proportions after the main mixing process is not allowed.

(2) In special cases, admixtures, pigments, fibres or water may be added where:

— this is under the responsibility of the producer;

— the consistence and the limiting values conform to the specified values; and

— there is a documented procedure for undertaking this process in a safe manner within the factory production control.

(3) Furthermore, if water is added, a conformity control shall be carried out on a sample of the final product.

(4) The quantity of any water, admixtures, pigments or fibres (if the content of fibres is specified), added to the truck mixer shall be recorded on the delivery ticket in all cases. For re-mixing, see 9.8.

NOTE For further information see Annex L, line 15.

8 Conformity control and conformity criteria

8.1 General

(1) Conformity control comprises the combination of actions and decisions to be taken in accordance with conformity rules adopted in advance to check the conformity of the concrete with the specification of concrete. Conformity control is an integral part of production control (see Clause 9).

NOTE The properties of concrete used for conformity control are those measured by the appropriate tests using standardized procedures. The actual values of the properties of the concrete in the structure may differ from those determined by the tests depending on, e.g. dimensions of the structures, placing, compaction, curing and environment.

(2) The sampling and testing plan and conformity criteria shall conform to the procedures given in 8.2 or 8.3. These provisions apply also to concrete for precast products unless the specific product standard contains an equivalent set of provisions. If higher sampling rates are required by the specifier, this shall be agreed in advance. For properties not covered in these clauses, the sampling and testing plan, method of test and conformity criteria shall be agreed upon between the producer and the specifier.

(3) The place of sampling for conformity tests shall be chosen such that the relevant concrete properties and concrete composition do not change significantly between the place of sampling and the place of delivery. In the case of lightweight concrete produced with unsaturated aggregates, the samples shall be taken at the place of delivery.

(4) Where tests for production control are the same as those required for conformity control, they shall be permitted to be taken into account for the evaluation of conformity. The producer may also use other test data on the delivered concrete in the conformity assessment.

(5) The conformity or non-conformity is judged against the conformity criteria. Non-conformity may lead to further action at the place of production and on the construction site (see 8.4).

8.2 Conformity control for designed concrete

8.2.1 Conformity control for compressive strength

8.2.1.1 General

(1) For normal-weight and heavy-weight concrete of strength classes from C8/10 to C55/67 or lightweight concrete from LC8/9 to LC55/60, sampling and testing shall be performed either on individual concrete compositions or on concrete families of established suitability as determined by the producer unless agreed otherwise. The family concept shall not be applied to concrete with higher strength classes. Lightweight concrete shall not be mixed into families containing normal-weight concrete. Lightweight concrete with demonstrably similar aggregates may be grouped into its own family.

NOTE For guidance for the selection of concrete families, see Annex K. More detailed information for the application of the concrete family concept is given in CEN/TR 16369 and CEN Report CR 13901.

(2) In the case of concrete families, the producer shall achieve control over all family members and sampling shall be carried out across the whole range of concrete compositions produced within the family.

(3) Where conformity testing is applied to a concrete family, a reference concrete is selected which is either that most commonly produced or one from the mid-range of strength classes of the concrete family. Relationships are established between each individual concrete composition of the family and the reference concrete in order to be able to transpose test results for compressive strength from each individual concrete test result to the reference concrete. The relationships shall be reviewed on the basis of original compressive strength test data at every assessment period and when there are appreciable changes in the production conditions. In addition, when assessing conformity for the family, it has to be confirmed that each individual member belongs to the family (see 8.2.1.3).

(4) In the sampling and testing plan and the conformity criteria of individual concrete compositions or concrete families, distinction is made between initial production and continuous production.

(5) Initial production covers the production until at least 35 test results are available.

(6) Continuous production is achieved when at least 35 test results are obtained over a period not exceeding 12 months.

(7) If the production of an individual concrete composition, or a concrete family, has been suspended more than 12 months, the producer shall adopt the criteria, sampling and testing plan given for initial production.

(8) During continuous production, the producer may adopt the sampling and testing plan and the criteria for initial production.

(9) If the strength is specified for a different age, the conformity is assessed on specimens tested at the specified age.

(10) Where identity of a defined volume of concrete with a population verified as conforming to the characteristic strength requirements is to be assessed, this shall be in accordance with Annex B.

8.2.1.2 Sampling and testing plan

(1) Samples of concrete shall be randomly selected and taken in accordance with EN 12350-1. Sampling shall be carried out on individual concrete compositions or on each family of concrete produced under conditions that are deemed to be uniform. The minimum rate of sampling and testing of concrete shall be in accordance with Table 17 at the rate that gives the highest number of samples for initial or continuous production, as appropriate.

(2) Notwithstanding the sampling requirements in 8.1, the samples shall be taken after any water or admixtures are added to the concrete under the responsibility of the producer, but sampling before adding plasticiser or superplasticiser to adjust the consistence (see 7.5) is permitted where there is proof by initial testing that the plasticiser or superplasticiser in the quantity to be used has no negative effect on the strength of the concrete.

(3) The test result shall be that obtained from an individual specimen or the average of the results when two or more specimens made from one sample are tested at the same age.

(4) Where two or more specimens are made from one sample and the range of the test values is more than 15 % of the mean then the results shall be disregarded unless an investigation reveals an acceptable reason to justify disregarding an individual test value.

Table 17 — Minimum rate of sampling for assessing conformity

Production	Minimum rate of sampling		
	First 50 m³ of production	Subsequent to first 50 m³ of production[a], the highest rate given by:	
		Concrete with production control certification	Concrete without production control certification
Initial (until at least 35 test results are obtained)	3 samples	1 per 200 m³ or 1 per 3 production days[d]	1 per 150 m³ or 1 per production day[d]
Continuous[b] (when at least 35 test results are available)	---	1 per 400 m³ or 1 per 5 production days[c, d] or 1 per calendar month	

a Sampling shall be distributed throughout the production and should not be more than 1 sample within each 25 m³.

b Where the standard deviation of the last 15 or more test results exceeds the upper limits for s_n according to Table 19, the sampling rate shall be increased to that required for initial production for the next 35 test results.

c Or if there are more than 5 production days within 7 consecutive calendar days, once per calendar week.

d The definition of a ´production day´ shall be stated in provisions valid in the place of use.

8.2.1.3 Conformity criteria for compressive strength

8.2.1.3.1 Criteria for individual results

(1) Conformity of concrete compressive strength is assessed on specimens tested at 28 days in accordance with 5.5.1.2. Each individual test result, f_{ci}, shall satisfy:

$$f_{ci} \geq \left(f_{ck} - 4\right) \text{ N/mm}^2 \quad (1)$$

NOTE If the strength is specified for a different age, the conformity is assessed on specimens tested at the specified age.

8.2.1.3.2 Criteria for mean results

(1) The achievement of the specified characteristic strength shall be assessed by one of the following methods.

Method A: Initial production

(2) For initial production, the mean strength of non-overlapping or overlapping groups of three consecutive results shall satisfy:

$$f_{cm} \geq \left(f_{ck} + 4\right) \text{ N/mm}^2 \quad (2)$$

NOTE 1 The conformity criteria are developed on the basis of non-overlapping test results. Application of the criteria to overlapping test results increases the risk of rejection.

Method B: Continuous production

(3) Method B is an option when conditions of continuous production are established.

(4) Conformity assessment shall be made on test results taken during an assessment period that shall not exceed the period given by one of the following options depending on the rate of testing:

— for plants with lower testing rates (number of test results for designed concrete less than 35 per three months), the assessment period shall comprise at least 15 results and not more than 35 consecutive results taken over a period not exceeding 6 months;

— for plants with higher testing rates (number of test results for designed concrete 35 or more per three months) the assessment period shall comprise at least 15 consecutive results and not exceed three months.

(5) The mean strength of non-overlapping or overlapping groups of consecutive test results obtained from a single concrete or a concrete family in an assessment period shall satisfy:

$$f_{cm} \geq \left(f_{ck} + 1,48\sigma\right) \text{ N/mm}^2 \quad (3)$$

(6) Where this method is applied to a concrete family, the mean of all non-transposed test results (f_{cm}) for a single family member shall be assessed against the criterion given in Table 18. Any concrete failing this criterion shall be removed from the family and assessed individually for conformity.

(7) The removed concrete (or concretes) shall be assessed individually for conformity, using the conformity criteria established for initial production (Method A). The reintegration of the removed concretes is accepted, only after revision of the established relationships between the removed composition and the reference concrete.

Table 18 — Confirmation criterion for family members

Number *n* of test results for compressive strength for a single family member	**Mean of *n* results (f_{cm}) for a single family member** N/mm^2
2	$\geq f_{ck}$ - 1,0
3	$\geq f_{ck}$ + 1,0
4	$\geq f_{ck}$ + 2,0
5	$\geq f_{ck}$ + 2,5
6	$\geq f_{ck}$ + 3,0
7 to 9	$\geq f_{ck}$ + 3,5
10 to 12	$\geq f_{ck}$ + 4,0
13, 14	$\geq f_{ck}$ + 4,5
≥ 15	$\geq f_{ck}$ + 1,48 σ

NOTE 2 For guidance for the selection of concrete families, see Annex K.

(8) At the end of initial production, the standard deviation (σ) of the population shall be estimated from at least 35 consecutive test results taken over a period exceeding three months. When continuous production commences, this value of standard deviation shall be used to check the conformity over the

first assessment period. At the end of the first and subsequent assessment periods, the standard deviation is checked to determine whether it has changed significantly using the limits given in Table 19. If it has not changed significantly, the current estimate of the standard deviation applies to the following assessment period. When there is a significant change in standard deviation, a new standard deviation is calculated from the most recent 35 consecutive results and applied to the following assessment period.

NOTE 3 For further information see Annex L, line 16.

Table 19 — Values for verification of standard deviation

Number of test results	Limits for s_n
15 to 19	$0{,}63\ \sigma \le s_n \le 1{,}37\ \sigma$
20 to 24	$0{,}68\ \sigma \le s_n \le 1{,}31\ \sigma$
25 to 29	$0{,}72\ \sigma \le s_n \le 1{,}28\ \sigma$
30 to 34	$0{,}74\ \sigma \le s_n \le 1{,}26\ \sigma$
35[a]	$0{,}76\ \sigma \le s_n \le 1{,}24\ \sigma$
[a] In case of more than 35 test results ▌A1⟩ Formula (L.1) ⟨A1▐ applies.	

Method C: Use of control charts

(9) Method C is an option for assessing conformity by the use of control charts when conditions of continuous production are established and where the concrete production is covered by third party certification.

(10) The control system shall comprise the application of a recognised model of control chart and have the following characteristics:

— achieve a maximum average outgoing quality (AOQ) not exceeding 5,0 %;

— aim to ensure conformity of the relevant production with the required characteristic strength;

— include regular monitoring of strength and standard deviation or deviations from target values;

— where applicable, include one or more procedures for speeding the response of the system (e.g. use of early strength data, use of concrete families);

— define and apply clear decision rules for conformity and warning limits;

— when the control chart shows that the standard deviation is ≥ 0,5 N/mm^2 above the currently applied value, change the applied value.

NOTE 4 For further information see Annex L, line 17.

(11) One of the rules of application given in Annex H or in provisions valid in the place of use that meet the requirements of 8.2.1.3.2 (10) shall be applied.

NOTE 5 Annex H gives a method of application for cusum control charts and for Shewhart control charts with examples of conformity rules that achieve an average outgoing quality limit not exceeding 5,0 %. Guidance on values other than those given in Annex H are given in CEN/TR 16369, which for cusum control charts is based on [1].

8.2.2 Conformity control for tensile splitting strength

8.2.2.1 General

(1) 8.2.1.1 applies, but the concept of concrete families is not applicable. Each concrete composition shall be assessed separately.

NOTE For further information see Annex L line 18.

8.2.2.2 Sampling and testing plan

(1) 8.2.1.2 applies.

8.2.2.3 Conformity criteria for tensile splitting strength

(1) Where tensile splitting strength of concrete is specified, conformity assessment shall be made on test results taken during an assessment period that shall not exceed the period given by one of the following options depending on the rate of testing:

— for plants with lower testing rates (number of test results for designed concrete less than 35 per three months), the assessment period shall comprise at least 15 and not more than 35 consecutive results taken over a period not exceeding 6 months;

— for plants with higher testing rates (number of test results for designed concrete 35 or more per three months) the assessment period shall comprise at least 15 consecutive results and not exceed three months.

(2) Conformity of concrete tensile splitting strength is assessed on specimens tested at 28 days, unless a different age is specified in accordance with 5.5.1.3 for:

— groups of n non-overlapping or overlapping consecutive test results $f_{ctm,sp}$ (criterion 1);

— each individual test result $f_{cti,sp}$ (criterion 2).

(3) Conformity with the characteristic tensile splitting strength ($f_{ctk,sp}$) is confirmed if the test results satisfy both the criteria in Table 20 for either initial or continuous production as appropriate.

Table 20 — Conformity criteria for tensile splitting strength

Production	**Number n of results in the group**	**Criterion 1**	**Criterion 2**
		Mean of n results ($f_{ctm,sp}$) N/mm^2	Any individual test result ($f_{cti,sp}$) N/mm^2
Initial	3	$\geq f_{ctk,sp} + 0,5$	$\geq f_{ctk,sp} - 0,5$
Continuous	Not less than 15	$\geq f_{ctk,sp} + 1,48\ \sigma$	$\geq f_{ctk,sp} - 0,5$

(4) The requirements for the standard deviation shall conform to 8.2.1.3.2, Method B.

8.2.3 Conformity control for properties other than strength

8.2.3.1 General

(1) Where other properties of concrete are specified, conformity assessments shall be made on the basis of individual loads for values for consistence, viscosity, passing ability, segregation resistance, air content and if fibres are added at the truck mixer homogeneity of fibre distribution in fresh concrete as stated in Table 21. For the other properties, conformity assessments shall be made as stated in Table 22 on production over the assessment period that shall not exceed 6 months.

NOTE 1 Where identity testing is carried out for assessing that a defined volume of concrete belongs to a given population verified as conforming to the requirements for concrete consistence, air content of fresh concrete or the specified minimum value of fibre content, the procedure to be applied is given in Annex B.

NOTE 2 The conformity criteria for an individual batch and the identity testing criteria are the same.

8.2.3.2 Sampling and testing plan

(1) Batches for testing shall be randomly selected and the samples of concrete taken in accordance with EN 12350-1. Sampling shall be carried out on each family of concrete produced under conditions that are deemed to be uniform. The minimum number of samples and the methods of test shall be in accordance with Table 21 or Table 22 as appropriate.

8.2.3.3 Conformity criteria for properties other than strength

(1) Conformity with the required property is confirmed where both

— individual test results are within the maximum allowed deviation given in Tables 21 and 22 or the tolerances on target values conform to Table 23;

— and the number of test results for the property given in Table 22 outside the specified limiting value or class limits or tolerances on target values as appropriate is not greater than the acceptance number in Table 24; alternatively, the requirement may be based on testing by variables in accordance with ISO 3951-1 (AQL = 4 %).

(2) Where the batch has failed the individual criterion, this batch is declared as non-conforming and this result is excluded from any further consideration of conformity of the remaining concrete.

Table 21 — Conformity assessment for consistence classes, SCC properties, air content and homogeneity of fibre distribution of fresh concrete at the point of delivery

Property	Test method or method of determination	Minimum number of samples or determinations	Maximum allowed deviation [a] at the point of delivery of single test results from limit values or for consistence the limits of the specified class	
			Lower limit	Upper limit
Appearance	Comparison by visual inspection of the appearance of this concrete with its normal appearance	Each batch; for vehicle deliveries, each load	-	-
Slump	EN 12350-2	i) Frequency as given in Table 17 for compressive strength ii) When testing air content iii) In case of doubt following visual inspection	-10 mm	+10 mm
			-20 mm [b]	+20 mm [b]
Degree of compactibility	EN 12350-4		-0,03	+0,03
			-0,04 [b]	+0,04 [b]
Flow	EN 12350-5		-10 mm -20 mm [b]	+10 mm +20 mm [b]
Slump flow	EN 12350-8		No deviation allowed	No deviation allowed
Viscosity	EN 12350-8 or EN 12350-9	If specified		
Passing ability	EN 12350-10 or EN 12350-12			
Segregation resistance	EN 12350-11			
Air content of air-entrained fresh concrete [d]	EN 12350-7 for normal-weight and heavy-weight concrete and ASTM C 173 for lightweight concrete	1 sample / production day [c]	-0,5 % by volume	+5,0 % by volume
Homogeneous mixing of fibres in fresh concrete where the fibres are added at the truck mixer	As given in B.5	Frequency [c] as given in Table 17 for compressive strength	As given in B.5	

a Where there is no lower or upper limit in the relevant consistence class, these deviations do not apply.

b Only applicable for consistence testing from initial discharge from truck mixer or agitating equipment (see 5.4.1).

c Except where provisions valid in the place of use require higher minimum test rates.

d See 6.2.3 (1), fourth bullet point.

Table 22 — Conformity assessment for fibre content, density, maximum water/cement ratio and minimum cement content

Property	Test method or method of determination	Minimum number of samples or determinations	Acceptance number	Maximum allowed deviation of single test results from limit values, from tolerance on a target value or from the limits of the specified class	
				Lower limit	Upper limit
Steel fibre content of fresh concrete	See 5.4.4	1 determination per day	See Table 24	-5 % by mass	No limit [a]
Polymer fibre content of fresh concrete	See 5.4.4	1 determination per day	See Table 24	-10 % by mass	No limit [a]
Density of heavy-weight concrete	EN 12390-7	As Table 17 for compressive strength	See Table 24	-30 kg/m^3	No limit [a]
Density of lightweight concrete	EN 12390-7	As Table 17 for compressive strength	See Table 24	-30 kg/m^3	+30 kg/m^3
Maximum Water/cement ratio, or Maximum Water/(cement + addition) ratio [b], or Maximum Water/(cement + k × addition) ratio [b]	See 5.4.2	1 determination per day	See Table 24	No limit [a]	+0,02
Minimum cement content, or Minimum (cement + addition) content [b], or Minimum (cement + k × addition) content [b]	See 5.4.2	1 determination per day	See Table 24	-10 kg/m^3	No limit [a]

a Unless limits are specified.

b Depending on the addition concept in use, see 5.4.2.