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**Products in fibre-reinforced cement —
Sampling and inspection**

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 390 was prepared by Technical Committee ISO/TC 77, *Products in fibre reinforced cement Study group for harmonization work*.

This second edition cancels and replaces the first edition (ISO 390:1977), of which it constitutes a technical revision.

Annexes A and B form an integral part of this International Standard. Annexes C and D are for information only.

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Products in fibre-reinforced cement — Sampling and inspection

1 Scope

This International Standard establishes rules for batching, sampling and inspection of fibre-reinforced cement products.

These rules apply to all acceptance tests. In certain cases they may also apply to type tests but the sampling scheme for type tests will usually be specified in the product standards.

These rules form a uniform method for determining whether consignments of fibre-reinforced cement products can be considered as conforming to relevant product standards.

This International Standard also gives guidelines for internal sampling and inspection of finished products from a continuous production process, allowing the relaxation of the rules concerning acceptance or rejection of inspection lots providing that the appropriate conditions have been fulfilled.

The quality system of the factory is outside of the scope of this International Standard.¹⁾

The sampling schemes are based on ISO 2859-1, ISO 3951, ISO 8422 and ISO 8423 with an AQL of 4 % and inspection level S3.²⁾ According to the results obtained on previous batches, either a reduced or a tightened control is applied in accordance with these Standards.

The methods of switching rules (normal, tightened or reduced inspection) are given in extracts of those Standards reproduced in annexes A and B.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publi-

cation, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 395:1983, *Asbestos-cement slates*.

ISO 881:1980, *Asbestos-cement pipes, joints and fittings for sewerage and drainage*.

ISO 2859-1:1989, *Sampling procedures for inspection by attributes — Part 1: Sampling plans indexed by acceptable quality level (AQL) for lot-by-lot inspection*.

ISO 3951:1989, *Sampling procedures and charts for inspection by variables for percent nonconforming*.

ISO 8422:1991, *Sequential sampling plans for inspection by attributes*.

ISO 8423:1991, *Sequential sampling plans for inspection by variables for percent nonconforming (known standard deviation)*.

ISO 9000:1987, *Quality management and quality assurance standards — Guidelines for selection and use*.

ISO 9001:1987, *Quality systems — Model for quality assurance in design/development, production, installation and servicing*.

ISO 9002:1987, *Quality systems — Model for quality assurance in production and installation*.

ISO 9003:1987, *Quality systems — Model for quality assurance in final inspection and test*.

1) Quality systems are described in ISO 9000, ISO 9001, ISO 9002 and ISO 9003.

2) As an alternative, sequential sampling can be used either by attribute (see ISO 8422) or by variable (see ISO 8423).

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 acceptable quality level (AQL): When a continuous series of lots is considered, the quality level which for the purposes of sampling inspection is the limit of a satisfactory process average.

NOTE 1 A sampling scheme with an AQL of 4 % means that batches containing up to 4 % defective items have a high probability of acceptance.

3.2 order: Quantity of a product or material ordered at one time from one producer.

NOTE 2 An order may consist of one or more consignments. See production batch (3.8) and inspection batch (3.9).

3.3 consignment: Quantity of products or material delivered at one time covered by one set of shipment documents.

NOTE 3 A consignment may consist of several lots or parts of lots. See also production batch (3.8) and order (3.2).

3.4 type test: Test for approval of a new product and/or a fundamental change in formulation or method of manufacture, or both. The test is performed on the as-delivered product.

The type test is not to be taken as evidence of the conformity to specification of products subsequently produced in quantity.

3.5 acceptance test: Test to establish whether a batch of products conforms to a specification. The tests are performed on samples drawn either from continuous production or from a consignment.

NOTE 4 Test methods and specification limit values are defined in the individual product standard. Sampling levels and acceptance criteria are defined in this International Standard.

3.6 inspection: Activities such as measuring, examining, testing and gauging one or more characteristics of a product, and comparing the results with designated requirements.

3.7 item: Actual or conventional object that can be individually considered and separately inspected.

NOTE 5 The term "individual" is sometimes used as a synonym for "item". The word "unit" is often used as a synonym for "item".

3.8 production batch: Quantity of product or material manufactured by one supplier under conditions presumed uniform i.e. manufactured from the same formulation on the same forming machine without

prolonged or abnormal interruptions and having the same acceptance requirement for the relevant test.

See also "inspection batch" (3.9), "consignment" (3.3) and "order" (3.2).

3.9 inspection batch: Definite quantity of some product or material collected together and submitted for examination or acceptance.

NOTE 6 An inspection batch may consist of several batches or parts of batches. See also "consignment" (3.3) and "order" (3.2).

3.10 inspected batch: Inspection batch that has been submitted to examination.

3.11 maximum size of inspection batch: Upper size limit of an inspection lot from which a certain sample has to be drawn to be submitted to inspection.

3.12 minimum size of inspection batch: Lower size limit of an inspection lot from which a certain sample has to be drawn to be submitted to inspection.

3.13 inspection by attributes: Method which consists in taking note, for every item of a population or of a sample taken from this population, of the presence or absence of a certain characteristic (attribute) and in counting how many items have or do not have this characteristic.

3.14 inspection by variables: Method which consists in measuring a quantitative characteristic for each item of a population or of a sample taken from this population.

3.15 sample: One or more items taken from an inspection batch at random irrespective of their quality and intended to serve as a basis for a decision on that lot.

3.16 sampling plan: Specific plan which states sample size or sizes to be used and the associated acceptance criteria. Verification of an inspection batch based upon the inspection of a sample.

3.17 single sampling: Sampling inspection in which the decision to accept or not to accept a batch is based on the inspection results obtained from a single sample of predetermined size n .

3.18 double sampling: Sampling inspection in which the inspection of the first sample of size n_1 leads to a decision to accept a batch or not to accept it or to take a second sample of size n_2 , and the second sampling inspection then leads to a decision of acceptance or rejection.

3.19 sequential sampling: Type of sampling which consists in taking successively items, or sometimes

groups of items, but without fixing their number in advance, the decision to accept or reject the batch being taken as soon as the results permit it, according to rules laid down in advance.

3.20 sample size: Number of items in the sample.

3.21 test specimen: Item or part of an item prepared for testing.

3.22 range: Difference between the greatest and the smallest observed values of a quantitative characteristic.

3.23 nonconformity: Non-fulfilment of a specified requirement.

3.24 nonconforming item; nonconforming unit: Item (unit) with one or more nonconformities.

3.25 acceptance: Conclusion after inspection that a batch or quantity of products satisfies the requirement criteria based on the results of the inspection.

3.26 non-acceptance; rejection: Conclusion after inspection that a batch, or quantity of products does not satisfy the requirement criteria based on the results of the inspection.

NOTE 7 When it is applied to the consignment from a producer, the term "rejection" means in a more liberal sense "non-acceptance of the batch under the conditions of the contract" (for example, the batch may be placed in another class, subjected to a lowering of price, etc.), and it is usual to specify the disposal of a rejected batch (e.g. return to supplier).

3.27 acceptance number, A_{c_n} : In sampling inspection by attributes, the highest number of nonconformities or nonconforming items (units) found in the sample that permits the acceptance of the batch.

3.28 rejection number; non-acceptance number, R_{e_n} : In sampling inspection by attributes, the lowest number of nonconformities or nonconforming items (units) found in the sample that requires the rejection of the batch.

4 Symbols

A_{c_1}, A_{c_2} Maximum number of nonconforming items for which a batch is accepted after inspection of the first or second sample respectively

A_n Criterion of acceptance at the n th item inspected in case of sequential sampling

$$A_n = Sn - h$$

(after inspection of n units)

A_t Constant of curtailment, determining whether the batch is to be accepted or not when the sequential inspection is curtailed at rank n

$$A_t = Sn_t - h$$

d_n Number of nonconforming items, in sequential sampling, counted after testing n samples

h Ordinate at the origin of the acceptance line

k Coefficient used for the calculations specified in table 2

n Rank of the item inspected ($n = 1, 2, \dots$)

n_0 Minimum number of pieces (items or units) to inspect, to accept the batch

n_t Value of n , fixed in advance, at which the sequential inspection is curtailed where required

Re_1, Re_2 Minimum number of nonconforming items which may lead to rejection after inspection of the first or second sample respectively

R_n Criterion of non-acceptance at the n th item inspected in case of sequential sampling

$$R_n = Sn + h$$

(after inspection of n units)

S Slope shared by the acceptance and the non-acceptance line

5 Inspection of consignment of finished products

5.1 Division into inspection batches

5.1.1 Homogeneous consignments

5.1.1.1 Any homogeneous consignment (or sub-consignment, see 5.1.2) shall be divided by the manufacturer into inspection batches, the maximum size of which shall be as given in the relevant International Standard.

5.1.1.2 Any fraction of a consignment remaining after removal of the highest possible number of maximum inspection batches and any homogeneous consignment (or sub-consignment) smaller than the maximum batch size shall form an inspection batch if larger than the minimum batch size given in the relevant International Standard.

5.1.1.3 Consignments or fractions of consignments smaller than the minimum batch size given in the relevant International Standard shall not be submitted to sampling and testing except by mutual agreement of all the interested parties.

5.1.2 Non-homogeneous consignments

Any consignment which is known to be or is expected to be non-homogeneous as regards any of the properties to be inspected by sampling shall be divided by the manufacturer into assumed homogeneous sub-consignments prior to the division into inspection batches in accordance with 5.1.1.

5.2 Sampling from consignment

5.2.1 From each inspection batch (see 5.1.1.1 and 5.1.1.2), the purchaser may draw a sample, the size of which is indicated in table 1 (see 5.2.2 and 5.2.3).

5.2.2 The entry to table 1 is the size of the inspection batch (column 1).

5.2.3 The products where all units undergo a compulsory non-destructive test during manufacture shall not be tested for this characteristic; if inspection of this characteristic is still required, a reduced sampling (table 5) will be used.

5.2.4 A reduced level of sampling (table 5) will also apply if the conditions of 5.1 are fulfilled.

5.2.5 When test specimens are cut from the units of the sample, the cutting is normally carried out by the manufacturer in the presence of the purchaser or his representative. This may only be modified by agreement between the interested parties.

5.3 Interpretation of results

5.3.1 Presentation and interpretation of table 1

5.3.1.1 Each item shall be inspected or tested as specified in the relevant product standard.

5.3.1.2 The inspection results shall be interpreted either by the method of inspection by attributes (see 5.3.1.4, 5.3.2 and 5.3.3) or by the method of inspection by variables (see 5.3.1.5 and 5.3.4).

5.3.1.3 The method of inspection by attributes is normally employed. However, by agreement between the interested parties prior to the drawing of the samples (see 5.2.1), the method of inspection by variables, if applicable, may be chosen.

5.3.1.4 When the method of inspection by attributes is employed, then the acceptability of the inspection batch shall be determined as prescribed in 5.3.2 and 5.3.3 based on the number of nonconforming items.

5.3.1.5 When the method of inspection by variables is employed, the test results shall be recorded so as to retain the order in which the items are selected and the acceptability of the inspection batch determined as prescribed in 5.3.4.

5.3.2 Inspection by attributes — Double sampling

5.3.2.1 When the number of nonconforming items found in the first sample is equal to or less than the acceptance number Ac_1 (3.27) indicated in column 5 of table 1, the inspection batch from which the sample was drawn is accepted.

5.3.2.2 When the number of nonconforming items found in the first sample is equal to or greater than the rejection number Re_1 (3.28) indicated in column 6 of table 1, the inspection lot is not accepted.

5.3.2.3 When the number of nonconforming items found in the first sample lies between the acceptance number and the rejection number (columns 5 and 6 of table 1), a second sample of the same size as the initial sample shall be drawn and examined.

5.3.2.4 The number of nonconforming items found in the first and second samples shall be combined.

5.3.2.5 If the total number of nonconforming items is equal to or less than the acceptance number Ac_2 indicated in column 8 of table 1, the inspected batch is accepted.

5.3.2.6 If the total number of nonconforming items is equal to or greater than the second rejection number Re_2 indicated in column 9 of table 1, the inspected batch is not accepted.

5.3.2.7 When the relevant International Standard calls for more than one property to be tested, the second sample taken (see 5.3.2.3) shall only be inspected for those properties which in the inspection of the first sample gave a number of nonconforming items between the acceptance number Ac_1 and the rejection number Re_1 .

Table 1 — Sampling and acceptance criteria to be used when conditions in 6.1 are not fulfilled

Sampling	Single		Double						Sequential				
Method by:	Variables		Attributes						Attributes				
Batch size	Sample	k	1st Sample			1st + 2nd Sample			Coefficients		Size		
			Size	Ac ₁	Re ₁	Size	Ac ₂	Re ₂	h	S	n ₀	n _t	A _t
1	2	3	4	5	6	7	8	9	10	11	12	13	14
31 to 50									0,632	0,210 8	3	5	1
51 to 90									0,664	0,132 7	5	8	1
91 to 150									0,898	0,144 6	7	14	2
151 to 3 200	7	0,405	8	0	2	16	1	2	1,030	0,126 4	9	20	2
3 201 to 10 000	10	0,507	13	0	3	26	3	4	1,299	0,131 8	10	30	3
10 001 to 35 000	15	0,536	13	0	3	26	3	4	1,299	0,131 8	10	30	3
35 001 to 150 000	25	0,571	20	1	4	40	4	5	1,540	0,113 6	14	48	5
150 001 to 500 000	30	0,577	20	1	4	40	4	5	1,540	0,113 6	14	48	5
> 500 001	40	0,591	32	1	5	64	6	7	1,912	0,112 8	17	75	8

NOTES

- 1 This table does not contain single or double sampling plans for batch sizes less than 151 items because they would not be severe enough.
- 2 For batch sizes less than 31 items, a special sampling plan may be drafted by agreement between the producer and the purchaser.
- 3 The sampling plan for batch sizes between 31 and 50 items is included for guidance only. A more efficient plan may be drafted by agreement between the producer and the purchaser.

5.3.3 Inspection by attributes — Sequential sampling

5.3.3.1 Draw at random a sample of n_t specimens (table 1, column 13) according to the size of the batch (table 1, column 1) and renumber them from 1 to n_t in the order in which they have been drawn.

5.3.3.2 Test the first n_0 specimens (table 1, column 12) in order of sampling.

5.3.3.3 Count the number of nonconforming items d_n after each test.

5.3.3.4 Compute A_n and R_n (see notes in table 1).

5.3.3.5 If $d_n \leq A_n$ the lot is accepted.

5.3.3.6 If $d_n \geq R_n$ the lot is not accepted.

5.3.3.7 If $A_n < d_n < R_n$ test the next sample and continue to follow the same procedure as in 5.3.3.3 and determine the acceptability and non-acceptability criterion corresponding to the new number of test. Start again with 5.3.3.5.

5.3.3.8 When $n = n_t$ the test is curtailed.

If $d_n \leq A_t$ the batch is accepted.

If $d_n > A_t$ the batch is not accepted.

NOTE 8 The criterion A_n is only relevant for $n_0 \leq n < n_t$.

5.3.4 Inspection by variables

The inspection shall be carried out on one sample, the size of which is given in column 2 of table 1 as follows.

5.3.4.1 Divide the readings in the order in which they have been recorded (see 5.3.1.5) into groups of 5, except when the sample size is 7, in which case the groups size is the same as the sample size.

5.3.4.2 For each group, compute the range R .

5.3.4.3 From the group ranges R compute the average range \bar{R} .

5.3.4.4 Compute the sample mean \bar{X} by dividing the sum of the measurements by the sample size.

5.3.4.5 Obtain from table 1 (column 3) the coefficient k .

5.3.4.6 Compute the acceptability limit AL and determine the acceptability by means of table 2.

Table 2 — Acceptance criteria for inspection by variables

Limit prescribed in relevant International Standard	AL	Acceptance if	Rejection if
Lower specified limit L_1	$L_1 + k\bar{R}$	$\bar{X} \geq AL$	$\bar{X} < AL$
Upper specified limit L_u	$L_u - k\bar{R}$	$\bar{X} \leq AL$	$\bar{X} > AL$

6 Inspection of finished products from continuous production process

6.1 General

The sampling scheme for continuous production shall have an AQL of 4 % or better. Alternative schemes³⁾ (e.g. using the standard deviation) to the following may be used providing that they meet this criterion. For cumulative, large batches, an AQL of 4 % and inspection level S3 is approximately equivalent to a fractile of 5 %.

3) See ISO 3951.

6.2 Sampling

6.2.1 The size of production batch for assessment, whether for initial testing or for retesting is chosen by the manufacturer including up to a maximum of one week's production.

6.2.2 The size limits of inspection batches (see 3.11 and 3.12) do not apply to production batches.

6.2.3 Items are drawn at random during their production, suitably marked, cured and stored in the same manner as the rest of the batch.

6.2.4 The number of items submitted to each test is indicated in tables 3 to 5.

6.2.5 The entry into the tables is the size of the production batch.

6.3 Testing and interpretation of results

6.3.1 Testing shall be carried out as specified in the appropriate product standard.

6.3.2 The sampling and interpretation of results shall be based on either the method of inspection by attributes or by the method of inspection by variables.

6.3.3 The choice of method is at the discretion of the manufacturer.

6.3.4 When the method of inspection by attributes is employed, then the acceptability of the batch shall be determined as prescribed in 5.3.2, based on the number of nonconforming items but using table 3, 4 or 5, depending on the case.

6.3.5 When the method of inspection by variables is employed the test results shall be recorded so as to retain the order in which the items are selected and the acceptability of the batch determined as prescribed in 5.3.4 but using table 3, 4 or 5, depending on the case.

6.4 Retesting of nonconforming batches

6.4.1 When a production batch is deemed to be unacceptable following initial inspection, the products may be subsequently reinspected for those characteristics which failed the initial inspection.

6.4.2 For the purposes of retest, the batch may be resubmitted in its entirety or subdivided into smaller homogeneous batches.

6.4.3 Results shall be interpreted using table 4 irrespective of the initial inspecting scheme (normal, tightened or reduced) according to the schemes of ISO 2859-1 (see annex A) and ISO 3951 (see annex B) but using the same method (attributes or variables).

6.4.4 The entry to table 4 is given by the size of the production batch or the size of the new batches when a subdivision has been made.

Table 3 — Inspection of finished products from continuous production process — Normal inspection

Size of batch	Inspection by attributes — Double sampling					Inspection by variables — Single sampling	
	Sample size ¹⁾	Initial sample		Initial sample + Second sample ¹⁾		Sample size	Acceptance coefficient <i>k</i>
		Ac ₁	Re ₁	Ac ₂	Re ₂		
1	2	3	4	5	6	7	8
≤ 150	3	0	1	NA ²⁾	NA ²⁾	3	0,502
151 to 280	8	0	2	1	2	3	0,502
281 to 500	8	0	2	1	2	4	0,450
501 to 1 200	8	0	2	1	2	5	0,431
1 201 to 3 200	8	0	2	1	2	7	0,405
3 201 to 10 000	13	0	3	3	4	10	0,507
10 001 to 35 000	13	0	3	3	4	15	0,536
35 001 to 150 000	20	1	4	4	5	25	0,571
150 001 to 500 000	20	1	4	4	5	30	0,577
≥ 500 001	32	2	5	6	7	40	0,591

NOTES

- 1 For inspection by attributes, the table is drawn from table III-A of ISO 2859-1:1989.
 - 2 For inspection by variables, the table is drawn from table RII-A of ISO 3951:1989.
- 1) In the case of the second sample, its size shall be the same as of the initial sample.
 2) NA = Not applicable.