INTERNATIONAL STANDARD

ISO 14655

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Epoxy-coated strand for the prestressing of concrete

Toron pour la précontrainte du béton avec revêtement époxy

Reference number
ISO 14655:1999(E)

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 14655 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 16, *Steels for the reinforcement and prestressing of concrete*.

Annexes A and B form a normative part of this International Standard. Annex C is for information only.

Epoxy-coated strand for the prestressing of concrete

1 Scope

This International Standard specifies requirements for fusion-bonded, epoxy-coated, or epoxy-coated and filled, seven-wire prestressing steel strand for the prestressing of concrete.

NOTE Use of epoxy-coated strand in pre-tensioned applications such as fire-rated construction should be approached with caution.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 2808:1997, *Paints and varnishes — Determination of film thickness*.

ISO 6272:1993, *Paints and varnishes — Falling weight test*.

ISO 6892:1998, *Metallic materials — Tensile testing at ambient temperature.*

ISO 6934-4:1991, *Steel for the prestressing of concrete — Part 4: Strand*.

ISO 9227:1990, *Corrosion tests in artificial atmospheres — Salt spray tests*.

3 Terms and definitions

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

3.1
coated and filled strand
epoxy-coated seven-wire strand in which the void spaces between the wires are completely filled with the epoxy coating to prevent migration of corrosive media, either by capillary action or other hydrostatic forces

3.2
coated strand
seven-wire prestressing steel strand which has been coated with a fusion-bonded epoxy coating

3.3
disbonding
loss of adhesion between the fusion-bonded epoxy coating and the strand

3.4
fusion-bonded epoxy coating
coating containing pigments, thermosetting epoxy resins, crosslinking agents, and other additives, which have been applied in the form of a powder on to a clean, heated metallic substrate and fused to form a continuous barrier

3.5
grit
inert particles that are impregnated into the surface of the coating

3.6
grit-impregnated strand
coated strand with grit impregnated into the surface of the coating

3.7
holiday
discontinuity in a coating which is not discernible to a person with normal or corrected vision

3.8
manufacturer
any organization which produces coated strand

3.9
sealing material
a coating system, formulated to be compatible with the fusion-bonded epoxy coating, used to repair damaged areas and cut ends

3.10
test unit
the quantity of coated strand to be accepted or rejected together, on the basis of the tests to be carried out on sample products in accordance with the requirements of the product standard or order

NOTE Adapted from ISO 404:1992.

4 Materials

4.1 Prestressing steel strand

Prestressing steel strand to be coated shall be in accordance with ISO 6934-4 or any other product standard as specified by the purchaser, and shall be free of contaminants such as oil, grease or paint.

4.2 Epoxy powder

The epoxy powder shall comply with the requirements listed in annex B. The material shall be of organic composition except for the pigment, or grit if applicable, which may be inorganic if used.

The purchaser shall be furnished a written certification that properly identifies the batch designation of the epoxy powder used in the order, quantity represented, date of manufacture, name and address of the powder manufacturer and a statement that the supplied epoxy powder is the same composition as that which was qualified under the requirements of annex B.

If specified in the order, a representative 0,25 kg sample of the epoxy powder material shall be supplied to the purchaser. The sample shall be packaged in an airtight container and identified by batch designation.

4.3 Sealing material

The coating system, for use as sealing material, shall be compatible with the fusion-bonded epoxy coating, inert in concrete and recommended by the epoxy powder manufacturer. The sealing material shall be suitable for repairs at the manufacturer or at the site. The material shall comply with the requirements of annex B.

When specified in the order, sealing material shall be supplied to the purchaser.

5 Surface preparation of prestressing steel strand

The surface of the prestressing steel strand to be coated shall be cleaned chemically or by other methods that will not impair the prestressing steel strand.

6 Application of coating

The coating shall be applied to the cleaned surface as soon as possible after cleaning and before re-oxidation of the surface occurs as discernible to a person with normal or corrected vision. However, in no case shall application of the coating be delayed more than 10 min after cleaning.

The fusion-bonded epoxy powder coating shall be applied in accordance with the written recommendations of the manufacturer of the coating material for initial steel surface temperature range and post-application cure requirements. The temperature of the surface immediately prior to coating shall be measured using infrared guns and/or temperature-indicating crayons at least once every 10 min during continuous operations.

NOTE 1 The use of infrared guns and temperature-indicating crayon measurement of the coated prestressing steel strand is recommended.

The coating shall be applied by electrostatic deposition or other suitable method.

NOTE 2 Periodic checks of the coating's cure by Differential Scanning Calorimetry is recommended.

The surface of the coating may be smooth or grit-impregnated.

Inert particles (grit) shall be impregnated into the surface of the coating when grit-impregnated strand is ordered. Such particles shall not cause the coating to fail the requirements of clause 7. The particles shall be inert in concrete and non-reactive with concrete additives and soluble salts.

The epoxy coating on the surface of grit-impregnated strand shall be capable of reaching a temperature of 66 °C without reducing the transfer of prestressing due to the strand bonding to the surrounding concrete.

WARNING At temperatures above 74 °C, currently available epoxy powder coatings begin to soften and lose ability to transfer load from strand to concrete by bond. At 93 °C practically all transfer capacity will be lost.

7 Requirements for coated prestressing steel strands

7.1 Coating thickness

For coated strand, the coating thickness after curing shall be between 650 µm and 1 150 µm.

A coating thickness less than 650 µm may be agreed upon between purchaser and manufacturer.

NOTE If a coating thickness less than 650 µm is agreed upon, the manufacturer should submit test data to demonstrate performance in accordance with this International Standard.

7.2 Mechanical properties

The coated strand shall satisfy the requirements for characteristic maximum force, 0,1 % proof force and elongation described in ISO 6934-4 or any other product standard as specified by the purchaser.

Epoxy-coated strand shall have relaxation losses of not more than 4 % after 1 000 h when initially loaded to 70 % of specified characteristic maximum force of the strand.

7.3 Coating continuity

After curing, the coating shall be free of holes, voids, cracks and damaged areas discernible to a person with normal or corrected vision.

Continuous holiday detection of the coated strand shall be performed. If more than two holidays per 30 m are detected, the strand shall be rejected and corrective action shall be instituted. Coated strand with two holidays or less per 30 m shall be repaired in accordance with the sealing material manufacturer's recommendation.

7.4 Coating adhesion

No cracking or disbonding of the coating on the outside radius of the bent strand shall be visible to a person with normal or corrected vision.

Except as specified in A.2, evidence of cracking or disbonding of the coating shall be considered cause for rejection of the coated strand represented by the bend test sample.

The coating adhesion shall also be evaluated by a tensile test. The test temperature shall be 23 °C $\pm$ 2 °C, and the rate of stressing shall be between 6 N/(mm^2·s) and 60 N/(mm^2·s). No cracks visible to a person with normal or corrected vision shall occur in the coating up to an elongation of 1 %.

7.5 Bond with concrete or grout

Pull-out tests shall be conducted on grit-impregnated coated strand to assure proper bond properties. See A.1.4.

8 Permissible coating damage and repair of damaged coating

The total damaged surface area, prior to repair with sealing material, shall not exceed 0,5 % of the surface area of the coated prestressing steel strand in any one metre length. This limit on repaired damage does not include sheared or cut ends that are coated with sealing material.

Coating damage discernible to a person with normal or corrected vision shall be repaired with sealing material meeting the requirements of 4.3 in accordance with the written recommendations of the sealing material manufacturer. Any rust shall be removed by suitable means before application of the sealing material.

The coating at repared areas shall have a minimum thickness of 650 μm.

9 Manufacturer's certificate

The manufacturer shall make available, when requested by the purchaser, a certificate of testing stating:

a) that the material supplied complies with the requirements of this International Standard;

b) the address at which the record of test results is available for inspection;

c) the identification symbol of the certification body, where applicable.

The manufacturer shall, when requested in the order, furnish a representative load-elongation curve for each size and grade of strand shipped and a copy of the manufacturer's quality control tests.

10 Handling and identification

All strapping bands shall be padded or suitable banding shall be used to prevent damage to the coating. All reels of coated strand shall be handled in such a manner as not to damage the coating on the strand. Coating damage due to handling shall be repaired in accordance with the written recommendations of the sealing material manufacturer. The repaired coating shall conform to the requirements of clause 7.

The reel number shall be maintained throughout the fabrication and coating process to the point of shipment for traceability.

11 Coated and filled strand

If specified in the order, or agreed upon between purchaser and manufacturer, the delivered strand shall be coated and filled.

For coated and filled strand, all requirements given in this International Standard shall apply, except for the following:

— the coating thickness after curing shall be 400 µm to 900 µm;

— epoxy-coated and filled strand shall have a relaxation loss of not more than 6,5 % after 1 000 hours when initially loaded to 70 % of the specified characteristic maximum force of the strand.

Annex A
(normative)

Test methods and frequency of tests, and retests

A.1 Test methods and frequency of tests

A.1.1 Coating thickness

A.1.1.1 Method of test

Measurements shall be made in accordance with method No. 6 of ISO 2808:1997 following the instructions for calibration and use by the thickness gauge manufacturer. Pull-off and fixed probe gauges may be utilized. Pencil-type pull-off gauges that require the operator to observe the readings at the instant the magnet is pulled from the surface shall not be used. The coating thickness shall be determined within a $\pm$ 5 % allowable error with a gauge capable of measuring along a curved surface.

The coating thickness shall be measured on the crown of the wires, on a straight length of the strand. The magnetic gauge shall be placed at one section on the strand and readings taken at the crown of each outer wire and averaged.

A.1.1.2 Frequency of tests

For each reel of strand, thickness measurements shall be conducted at five locations spaced approximately evenly along the manufactured length of the strand. Records of inspection during manufacturing shall be available when requested. It shall be permissible to reduce the frequency of thickness measurements if the manufacturer can demonstrate small coating thickness standard deviations to the satisfaction of the purchaser.

A.1.2 Coating continuity

During the coating process, a continuous holiday detection procedure shall be employed using an appropriate holiday detector. The procedure shall follow the written instructions furnished by the manufacturer of the holiday detector.

Holiday checks to determine the acceptability of the coated prestressing steel strand shall be made at the manufacturer's plant with an in-line minimum 67,5 V, 80 000 Ω, wet-sponge type direct current holiday detector or equivalent method. The testing voltage shall be fixed and the detector designed so that an external instrument can verify that it is correct. The detector shall be equipped with indicators such as a lamp and/or a buzzer for indicating discontinuities.

NOTE 1 Hand-held holiday detector checks should be performed regularly to verify the accuracy of the in-line system.

NOTE 2 To obtain an accurate holiday count, care should be taken to ensure that contact of the sponge along the entire steel surface being tested is maintained.

A.1.3 Coating adhesion

A.1.3.1 Method of test

The adhesion and shear strength of the coating shall be evaluated by bending a sample from a finished reel of coated strand 180° around a mandrel diameter equal to 32 times the nominal diameter of the strand. The test specimens shall be between 20 °C and 30 °C.

Fracture of a steel wire or the strand in the bend test for adhesion of coating shall not be considered as an adhesion failure of the coating, and another specimen from the same production shift may be substituted.

The coating adhesion shall also be evaluated by a tensile test in accordance with ISO 6892.

Sample length for the bend test shall be at least 1 500 mm. Sample length for the tensile test shall follow the requirements of ISO 6892.

A.1.3.2 Frequency of tests

Tests for coating adhesion shall be conducted at the end of each manufactured length.

A.1.4 Bond with concrete or grout

A.1.4.1 Method of test

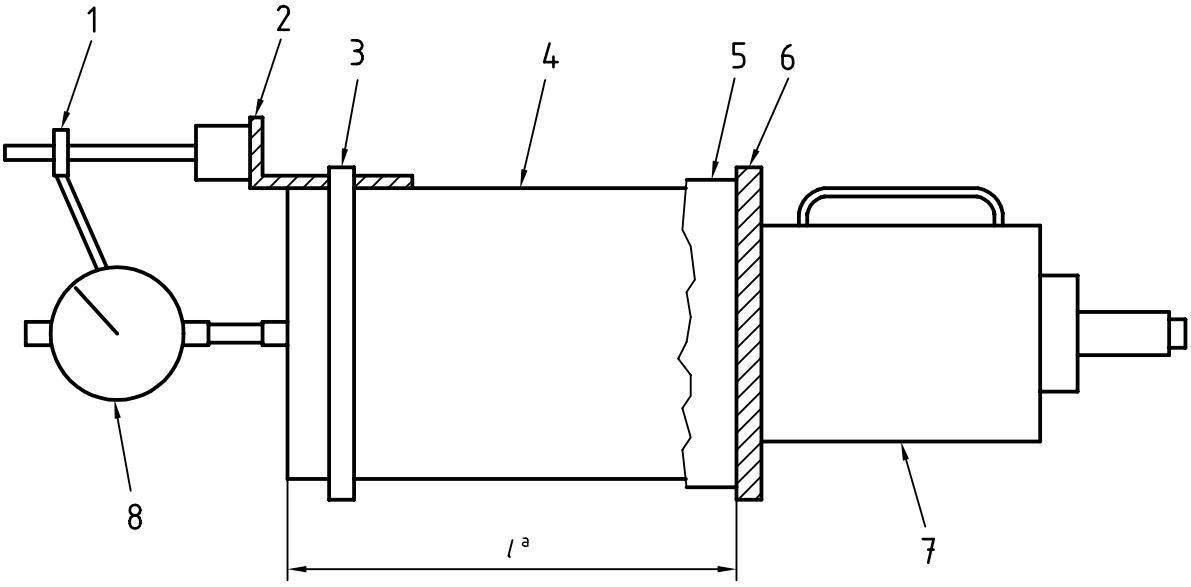
Pull-out specimens shall be cast in concrete cylinders with the dimensions shown in Table A.1. The untensioned strand shall be embedded concentrically along the longitudinal axis of the specimen. The test shall be conducted when the concrete reaches a compressive strength between 30 MPa and 35 MPa. Padding material shall be applied to provide a uniform support to the specimen and to make the strand perpendicular to the supporting surface. The loading shall be applied as shown in Figure A.1, by a hydraulic or mechanical jack. The load should be measured using a calibrated load indicator. A dial gauge shall be used at the unloaded end of the strand to indicate slip. Minimum force at 0,025 mm slip shall be at least equal to or greater than the values shown in Table A.1.

A.1.4.2 Frequency of tests

Pull-out tests shall be conducted once every 15 000 m of grit-impregnated strand produced. It shall be permissible to reduce the frequency of pull-out tests if the manufacturer can demonstrate small standard deviations to the satisfaction of the purchaser.

Table A.1 — Requirements for pull-out tests

Strand diameter mm	Cylinder diameter mm	Embedment length mm	Minimum force at 0,025 mm slip kN
9,3	150	195	9,7
9,5	150	190	9,7
10,8	150	170	9,8
11,1	150	165	9,9
12,4	150	155	10,2
12,7	150	150	10,5
15,2	150	140	11,5



Key

1 Magnetic mount
2 Bracket
3 Clamp
4 Cylinder, 150 mm diameter
5 Padding material
6 Bearing plate
7 Calibrated jack or jack and load cell, ± 2 % accuracy
8 Dial indicator, ± 2 % accuracy

[a] Embedment length

Figure A.1 — Recommended arrangement for pull-out testing

A.2 Retests

If the specimen for coating thickness, continuity, adhesion and pull-out tests fails to meet the specified requirements, two retest samples adjacent to the first sample from the same reel shall be conducted for each failed test. If the results of both retests meet the specified requirements, the test unit represented by the samples shall be accepted.

Annex B
(normative)

Prequalification requirements for epoxy powder coatings

B.1 Coating requirements

B.1.1 Chemical resistance

The chemical resistance of the coating shall be evaluated by partial immersion of coated test specimens in four different liquids for 45 d.

B.1.1.1 Equipment

B.1.1.1.1 Transparent closed test containers, sixteen in number and sized to completely encase one test specimen in a vertical position in each container and also large enough to provide adequate exposure to both the liquid and vapour states of reagent.

B.1.1.1.2 Chamber, in which the containers can be kept at 23 °C ± 2 °C.

B.1.1.1.3 Sharp-pointed knife.

B.1.1.2 Reagents

B.1.1.2.1 Distilled water.

B.1.1.2.2 3 mol/l aqueous solution of $CaCl_2$.

B.1.1.2.3 3 mol/l aqueous solution of NaOH.

B.1.1.2.4 Aqueous solution saturated with $Ca(OH)_2$.

B.1.1.3 Test specimens.

Sixteen lengths of coated strand, each 180 mm, shall be cut and sealed with sealing material. There shall be neither holidays nor any damage on the test specimens. The thickness of the coating shall be the minimum thickness to be applied on the prestressing strand, see 7.1.

In eight of the test specimens two holes 6 mm in diameter shall be made with their centres 45 mm from each end. Both holes shall lie in the same strand axis. The holes shall be made by drilling radially through the coating so that the angular cone point of the drill will fully enter the steel where the cylindrical portion of the drill meets the steel surface.

A control specimen shall be retained for comparison.

B.1.1.4 Procedure

Place a single specimen in a vertical position in each test container (B.1.1.1.1).

There shall be one reagent in each container. For each reagent, there shall be two containers with a drilled test specimen and two with an undrilled one.

Fill each container with the selected reagent so that the liquid level covers one half of the test specimen up to a point midway between the two holes. Stopper the container to prevent evaporation of the reagent and against contamination.

Maintain the temperature at 23 °C ± 2 °C for 45 d.

Remove the test specimens after 45 d of immersion. Wash with running water all specimens removed from the aqueous solutions and wipe them dry with a soft, clean, cotton cloth or paper tissue.

Observe and report before exposure to reagent, immediately after exposure to reagent and 2 h later the appearance of specimens on the basis of visual examination for evidence of loss of gloss, developed texture, decomposition, discoloration, softening, swelling, injury, bubbling, blistering, cracking, solubility, etc.

The control specimen is used for calibration of the lifting technique used for evaluation of the adhesion around the drilled holes. In this specimen, drill a 6 mm hole through the coating, keeping away from the cut end. Attempt to lift the coating at the new test hole with the point of a sharp knife (B.1.1.1.3) after making cuts through the coating intersecting at the centre of the hole. Inability or relative resistance to lifting or disbonding of the coating shall be considered the adhered or bonded condition of the untested coating with respect to the lifting technique used.

Determine if the coating has been loosened at the previously drilled test holes by attempting to lift the coating with the point of the knife after making intersections using the same technique as described in the above paragraph. Classify coating that can be lifted or disbonded more readily than at the new test hole as undercut area. Measure the undercut area.

B.1.1.5 Acceptance criteria

The coating shall not blister, soften, lose bond, or develop holidays. The coating surrounding the intentionally-made holes shall exhibit no undercutting during the 45 d period.

B.1.2 Chloride permeability

The coating's performance as chloride barrier shall be evaluated by this 45 d test.

B.1.2.1 Equipment

B.1.2.1.1 Two-compartment glass cell, as shown in Figure B.1.

The compartments are separated by two glass plates, each having centered, 24 mm diameter holes. The test specimen shall be sandwiched between the two glass plates, forming a membrane in the opening. The level in both compartments shall be equal when the liquid volumes are 115 ml and 175 ml in compartments 1 and 3 respectively. The opening shall then be completely immersed

B.1.2.1.2 Equipment capable of determining chloride concentrations down to 0,000 1 mol/l.

Activity measurements shall be converted into concentration values of moles per liter using a conversion diagram, constructed by plotting measured chloride ion activities versus known chloride ion concentrations

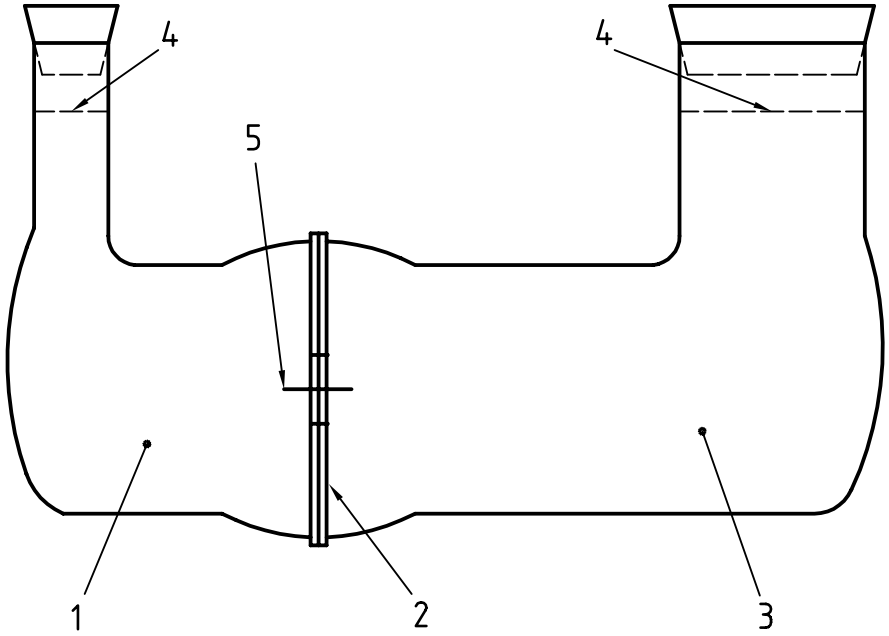
B.1.2.2 Test specimens

100 mm × 100 mm cured epoxy film without substrate. The thickness of the film shall be the minimum coating thickness to be applied on the prestressing strand, see 7.1.

The test specimen shall be carefully handled and examined for any defects prior to installation in the cell.

B.1.2.3 Procedure

The test specimen is placed between the two glass plates in the cell, with its centre in the plates' openings. The larger compartment is filled with 175 ml of 3 mol/l NaCl in water. The smaller one is filled with 115 ml of distilled water. After 45 d at 23 °C ± 2 °C, the chloride concentration in the smaller compartment is determined.



Key

1 115 ml compartment for distilled water
2 Epoxy film between two glass plates each having a centered 24 mm hole
3 175 ml compartment for 3 mol/l NaCl
4 Level mark
5 25 mm hole, centered

Figure B.1 — Permeability cell (example)

B.1.2.4 Acceptance criteria

The chloride concentration in the smaller compartment shall be less than 0,000 1 mol/l.

B.1.3 Abrasion resistance

The abrasion resistance shall be evaluated by the falling sand test.

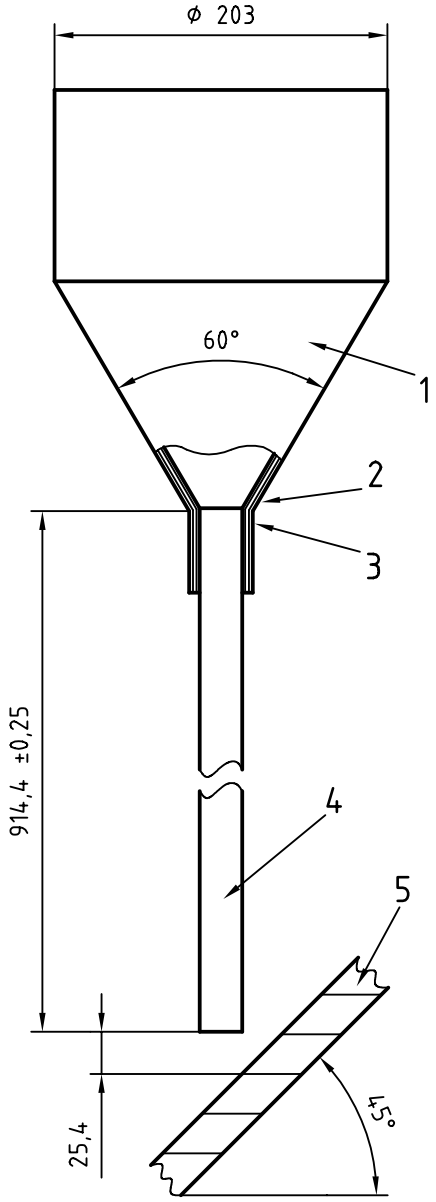
B.1.3.1 Equipment

B.1.3.1.1 Abrasion tester, as illustrated in Figure B.2.

A gate for starting the flow of abrasive is located near the top of the guide tube. It consists of a metal disc inserted into a slit in the side of the guide tube with a collar covering the slit. The guide tube shall be firmly supported in a vertical position over a suitable receptacle, which shall contain a support for holding the coated strand at an angle of 45° to the vertical, so that the opening of the tube is directly above the area to be abraded and the distance from the tube to the coated surface face at the nearest point is 25,4 mm when measured in the vertical direction. The base of the apparatus shall be fitted with adjusting screws for properly aligning the equipment.

NOTE A suitable abrasion tester may be obtained from Gardner/BYK-Gardner, Inc., Gardner Laboratory, 2435 Linden Lane, Silver Spring, MD 20910, USA. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results.

Dimensions in millimetres



Key

1 Funnel
2 Lower end of funnel, to be a cylindrical collar fitting snugly over outside of guide tube
3 Upper end of guide tube with both ends cut square and all burrs removed
4 Straight, smooth-bore, metal guide tube; inner diameter 19,05 mm ± 0,076 mm, outer diameter 22,225 mm ± 0,254 mm
5 Specimen

Figure B.2 — Design details of abrasion test apparatus

B.1.3.1.2 Natural silica sand, of which not more than 15 % of the grains in a sample are retained on a 0,85 mm wire-cloth sieve and not more than 5 % of the grains pass a 0,6 mm wire-cloth sieve after 5 min of continuous sieving.

NOTE In order to obtain improved reproducibility, sand from the St. Peters or Jordan sandstone deposits in the central United States should be used as reference material. This sand is characterized by its roundness of grains and its exceptionally high silicon dioxide content. It can be obtained from the Quakenbush Company, 500 East Main Street, Lake Zurich, IL 60047, USA or the U.S. Silica Co., P.O. Box 577, Ottawa, IL 61350, USA. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results.

B.1.3.2 Adjustment of sand flow

Pour a quantity of sand (B.1.3.1.2) into the funnel. Examine the sand stream falling from the lower end of the guide tube and align the apparatus (B.1.3.1.1) by means of the adjusting screws in the base until the inner concentrated core of the sand stream falls in the centre of the flow when viewed at two positions at 90° to each other. Introduce a measured volume of sand (2 000 ml ± 10 ml is a convenient amount) and determine the time of efflux. The rate of flow shall be 2 l of sand in 21 s to 23,5 s.

B.1.3.3 Test specimens

Two lengths of coated strand, each 100 mm or longer, shall be cut. There shall be neither holidays nor any damage on the test specimens. The thickness of the coating shall be the minimum coating thickness to be applied on the prestressing strand, see 7.1.

Condition the test specimens for at least 24 h at 23 °C ± 2 °C and (50 ± 5) % relative humidity.

B.1.3.4 Procedure

Conduct the test at 23 °C ± 2 °C and (50 ± 5) % relative humidity, or immediately on removal of the conditioned test specimens from this environment.

A test specimen is placed with a wire crown in the position where the centre of the sand flow will fall. The coating thickness shall first be measured at this point. The distance from the tube shall be as shown in Figure B.2.

Pour sand, measured volumetrically, into the funnel. Withdraw the gate and allow the sand to flow through the guide tube and impinge on the coated strand. Collect the sand in a container located at the bottom of the tester. Repeat this operation until the steel surface first appears. Register the sand volume used.

Repeat the procedure with one further test specimen from the same sample.

B.1.3.5 Acceptance criteria

The volume of sand required to remove 0,25 mm of coating shall be greater than 1 000 l. This requirement shall be applied to the average of two test specimens.

B.1.4 Impact test

The resistance of the strand coating to mechanical damage shall be determined by the falling weight test.

A test apparatus as described in ISO 6272 shall be used, but with a total falling mass of 1 800 g ± 1 g and a nose diameter of 16 mm ± 0,3 mm together with a compact support of rigid material instead of a die under the test specimen.

Impact shall occur on the crown areas of the coated strand. The test shall be performed at 23 °C ± 2 °C. With an impact of 9 N·m. No shattering, cracking or bond loss of the coating shall occur except at the impact area, that is, the area permanently deformed by the tup.

B.1.5 Salt spray (fog) test

Coated strand specimens shall be tensioned to 70 % of the specified nominal tensile strength and exposed to neutral salt spray (NSS) for 3 000 h in accordance with ISO 9227. Care shall be taken to protect the end anchorages used from salt fog or corrosion so as not to influence the test results. Observations for signs of corrosion shall be made and recorded every 250 h. After 3 000 h of exposure, no evidence of rust shall be present, and the specimens shall be holiday-free.

B.1.6 Elevated temperature test

B.1.6.1 Fabrication of test specimen

B.1.6.1.1 Pretension the coated strand to 75 % of its specified nominal tensile strength and anchor it in the support. If needed, add shims under the anchor in order to return to 75 % of nominal tensile strength after anchor seating loss.

B.1.6.1.2 Attach ten thermocouples to the strand, in pairs and at a distance from the end of 0,15 m, 0,6 m, 1,2 m, 1,8 m, and 2,3 m. Place pairs with one on each side of the strand.

B.1.6.1.3 Cast concrete around the pretensioned strand to make a square concrete bar 2,4 m long with the strand at the centre of the concrete cross-section. See Table B.1 for concrete cross-section dimensions. Use moist cure, heat cure or steam cure.

Table B.1 — Cross-section dimensions of 2,4 m long square concrete bar

Dimensions in millimetres

Strand nominal diameter	Bar cross-section
9,3	90 × 90
11,1	110 × 110
12,4	110 × 110
15,2	140 × 140

B.1.6.1.4 Release strand from anchors by gentle release or flame cut when concrete strength reaches approximately 28 MPa (see note). Do not release if temperature in concrete around strand exceeds 65 °C.

NOTE Strength of concrete at time of test should not affect test results as long as it is at least 28 MPa.

B.1.6.2 Procedure

B.1.6.2.1 Trim ends of strand so that motion of strand into concrete can be measured with a Linear Variable Differential Transformer (LVDT) or similar device.

B.1.6.2.2 Mount specimen in heating chamber, connect thermocouples that are placed in the concrete at the surface of the strand, and mount the LVDT at each end.

B.1.6.2.3 Apply heat so that the temperature measured by the thermocouples around the strand increases as steadily as possible. Rate of increase shall be between 0,5 °C /min and 1,4 °C /min. Increase rate as steadily and uniformly as possible along the square concrete bar.

B.1.6.2.4 At intervals of approximately 4 °C, record temperature and simultaneous readings of both LVDTs.

B.1.6.2.5 Continue heating to at least 88 °C.

B.1.6.2.6 For each temperature recorded, plot the average of the two LVDT readings against its corresponding temperature. The temperature at which this plot crosses the 0,25 mm line is the temperature rating of the strand being tested for comparison to the requirements of clause 6.

B.2 Acceptance testing

B.2.1 Testing agency

Acceptance tests shall be performed by an agency acceptable to the purchaser and to the manufacturer.

B.2.2 Frequency of tests

Tests for chemical resistance, chloride permeability, abrasion resistance, impact resistance, salt spray and elevated temperature shall be conducted as specified in B.1 whenever the coating formulation or supplier is changed.

B.2.3 Certification

Reports summarizing the results of all tests and bearing the signature of the testing laboratory shall be supplied to the manufacturer.

Annex C
(informative)

Guidelines for use of epoxy-coated strand

This International Standard is a product standard. Its requirements cease when the purchaser accepts the coated strand from the supplier. A product standard does not delineate requirements for subsequent use of the strand.

Proper use of epoxy-coated strand includes design considerations, handling, installing and stressing of strands, permissible concrete curing temperatures and procedures for repairing damaged coating and protection of the ends of strands. Information and procedures for such items are presented in a report [2].

Bibliography

[1] ISO 404:1992, *Steel and steel products — General technical delivery requirements.*

[2] *Guidelines for the Use of Epoxy-Coated Strand*, PCI Journal, Precast/Prestressed Concrete Institute, Vol. 38, No. 4, July-August 1993, pp. 26-32.

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