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INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ISO RECOMMENDATION
R 345

SHIPBUILDING DETAILS
TESTS ON GALVANIZED STEEL WIRE FOR ROPES

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BRIEF HISTORY

The ISO Recommendation R 345, *Shipbuilding Details—Tests on Galvanized Steel Wire for Ropes*, was drawn up by Technical Committee ISO/TC 8, *Shipbuilding Details*, the Secretariat of which is held by the Stichting Nederlands Normalisatie-instituut (NNI).

Work on this question by the Technical Committee began in 1952, taking into account the studies which had been made by the former International Federation of the National Standardizing Association (ISA), and led, in 1960, to the adoption of a Draft ISO Recommendation.

In October 1961, this Draft ISO Recommendation (No. 464) was circulated to all the ISO Member Bodies for enquiry. It was approved by the following Member Bodies:

Australia	Italy	Switzerland
Belgium	Netherlands	Turkey
Czechoslovakia	New Zealand	United Kingdom
Finland	Portugal	U.S.S.R.
France	Romania	Yugoslavia
India	Spain	

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Three Member Bodies opposed the approval of the Draft:

Germany, Japan, U.S.A.

The Draft ISO Recommendation was then submitted by correspondence to the ISO Council, which decided, in October 1963, to accept it as an ISO RECOMMENDATION.

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ISO Recommendation | R 345 | October 1963

SHIPBUILDING DETAILS

TESTS ON GALVANIZED STEEL WIRE FOR ROPES

1. SCOPE

The present ISO Recommendation concerns the testing of galvanized steel wire for wire ropes for shipping (see also ISO Recommendation R 346, *Shipbuilding Details — Galvanized Steel Wire Ropes*).

The zinc coating of steel wire ropes for shipping may, at the user's request, be of grade **A** or grade **B**, corresponding to different minimum conditions as determined by the results to be obtained from the tests set out below.

2. LIST OF TESTS

2.1 The zinc coating of wires should be checked by means of the following tests:

adhesion of zinc coating, see section 3, page 5;
mass of zinc deposited per unit of surface, see section 4, page 6;
continuity and uniformity of coating, see section 5, page 7.

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2.2 The quality of the galvanized steel wire should be checked by means of the following tests:

simple torsion, see section 6, page 9;
reverse bending, see section 7, page 10.

3. TEST FOR ADHESION OF ZINC COATING

3.1 Test specimen

The test specimen consists of a piece of wire long enough to allow the test to be carried out properly.

The test specimen is wound round a cylindrical mandrel so as to form ten close spirals. The ratio between the diameter of the mandrel and that of the wire is shown in table 1:

TABLE 1. — **Ratio between the diameter of mandrel and of the wire**

Galvanizing grades	Wires of diameter 0.3 to 1.45 mm	Wires of diameter 1.5 mm and over
A	4	6
B	2	3

3.2 Procedure

Winding should be carried out at as uniform a speed as possible and, in any case, not so rapidly as to give rise to any noticeable overheating of the coating.

After winding on the mandrel of appropriate diameter, the outside surface of the spirals should show no sign of peeling or of serious cracks in the zinc coating.

The zinc coating may therefore be considered as satisfactory if any small cracks, which may be detected after examination with the naked eye, are such that it is not possible to detach the zinc coating by simply rubbing with the fingers, the use of the finger-nail not being allowed.

4. DETERMINATION OF MASS OF ZINC DEPOSITED PER UNIT OF SURFACE

4.1 General

The test consists in dissolving the zinc coating of a sample of wire of given dimensions in a hydrochloric acid solution. The mass of zinc so dissolved is determined either by the difference in mass of the sample before and after dissolving the coating (gravimetric method), or by measuring the volume of hydrogen released during dissolution of the coating (gas volumetric method). By relating the mass of zinc determined in this way to the surface of the sample measured after dissolving the coating, the mass of zinc deposited per unit of surface is obtained.

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The gas volumetric method is the easiest to carry out. In case of argument, however, the gravimetric method, by accurately weighing the sample before and after stripping the zinc coating, should be used as a check.

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4.2 Test specimens

After carefully straightening the samples of wire, test specimens should be cut to a length of

300 mm for wires of less than 1.00 mm diameter,
150 mm for wires 1.00 to 1.49 mm diameter,
100 mm for wires 1.5 to 3 mm diameter,
50 mm for wires of more than 3 mm diameter.

Care should be taken to see that these lengths are accurate.

4.3 Apparatus

The apparatus used is shown diagrammatically in the sketch hereunder and consists essentially of the following elements:

(1) *tube graduated* at least in ml, with a tap at each end,

(2) *flask* whose lower nozzle is connected by a rubber tube to the bottom of the graduated tube,

beaker used for removing the samples.

4.4 Procedure

With tap *b* closed, the graduated tube and part of the flask are filled with hydrochloric acid solution containing a suitable inhibitor, e.g. hexamethylene tetramine, antimony trichloride, antimony trioxyde.

The level of the liquid in the graduated tube is raised in the graduated tube to just under the tap *a* by raising the acid reservoir flask until the two levels are the same.

After introducing the test specimen of the wire to be tested, tap *a* is closed and the hydrogen released by the action of the acid on the zinc coating accumulated in the upper part of the graduated tube.

When hydrogen is no longer being released, the flask is lowered in relation to the graduated tube so as to bring the levels of the solution in the tube and in the flask onto the same plane. The position of the meniscus of the liquid in the tube then indicates the volume of hydrogen released.

The remaining part of the solution contained in the graduated tube is collected in the flask by placing the flask on the table and opening tap *a*.

Tap *b* is then opened so that the test specimen of the wire can be collected in the beaker. This specimen is washed and carefully wiped before measuring its dimensions.

The test is made on one wire at a time, the temperature in the tube being held at 20 ± 2 °C.

4.5 Expression of results

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The result is determined after 10 tests.

If z = mass of zinc deposited per unit of surface,
d = bare wire diameter in millimetres,
l = length of a test specimen of wire in millimetres,
x = mean number of millilitres (cubic centimetres) of hydrogen released during each of the 10 tests.

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we have

$$z = \frac{2720\ x}{\pi\, d\, l}\ \text{g/m}^2$$

Where the barometric pressure (P) is known to be outside the limits from 740 to 780 mm, the above formula should be multiplied by the factor $\frac{P}{760}$.

In practice, tables allow the mass of zinc per square metre of the surface of the uncoated wire to be read directly as a function of the diameter of this wire and of the volume of hydrogen released.
The masses to be obtained, expressed in terms of the diameters of the wires, are shown in Table 2, page 9.

5. TEST FOR CONTINUITY AND UNIFORMITY OF COATING

5.1 General

The test consists of dipping a sample of the wire for a given length of time, one or more times in succession, into a saturated solution of copper sulphate, which gradually dissolves the zinc coating and thus reveals any defects in the continuity of this coating.

The fact that the rate of solubility of the coating in the copper sulphate solution varies very appreciably according to the galvanizing process used prevents any other precise conclusion as to the thickness of the coating or its particular qualities of resistance to various kinds of corrosion. The dip test is intended only to reveal a serious eccentricity of coating or any other serious defect in uniformity which may exist even though the mass of zinc per unit of surface conforms with this ISO Recommendation.

5.2 Test specimen

The test specimen consists of a piece of wire about 250 mm long, roughly straightened by hand. This test specimen should be completely de-greased with benzene or trichlorethylene. It should then be rinsed in distilled water and wiped with clean cotton wool. After this, it should be held only at the part which is not to be dipped.

5.3 Reagent

The reagent used is a fresh saturated solution of copper sulphate, prepared from "pure for analysis" copper sulphate crystals ($CuSO_4 \cdot 5\ H_2O$), in the proportion of 360 g minimum of salt to 1 litre of distilled water, at a temperature of 20 ± 2 °C.

The solution should be prepared entirely while cold. In no case, even in order to complete this solution, should the liquid be heated. To prevent the operation from taking too long, the procedure may be as follows: the salt to be dissolved should be crushed and then reduced in small quantities by successive portions of the water to be used. When the salt is completely dissolved, the various partial solutions are combined and shaken. As a proof of saturation, a little of the salt should remain undissolved at the bottom of the vessel.

The use of "pure for analysis" copper sulphate does not dispense with the necessity of neutralizing the solution with an excess of chemically pure copper oxide (1 gramme per litre of solution) and of allowing to stand at least 24 hours before decanting the solution to be ready for use.

5.4 Procedure

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The reagent as specified above should be transferred to a glass container of at least 8 cm internal diameter so as to fill it to a depth of at least 10 cm. The test specimen of the wire is then repeatedly dipped into this reagent which should be maintained at a temperature of 20 ± 2 °C.

The test specimen, held vertically, should not touch the walls of the container nor should it be moved about during the period of immersion.

After each immersion, any deposited but non-adhering copper should be removed by lightly rubbing with cotton wool under running water.

The number and duration of the immersions to which each test specimen should be subjected, specified as a function of the diameter of the wire, are shown in Table 2, below.

To save time, a maximum of 6 test specimens may be tested simultaneously, provided that these test specimens do not touch one another.

The solution used should be renewed, whenever the series of tests carried out has resulted in dissolving a maximum of 5 grammes of zinc per litre of reagent.

After the specified number of dips, the final rinsing and the wiping dry, the test specimen should not show any adherent salmon-red deposit of metallic copper on the steel. Any deposit of metallic copper within 25 mm of the cut end should be disregarded.

At the end of the test, no point of the test specimen lying more than 25 mm from the end immersed should show any shiny adherent salmon-red copper deposit, indicating that the steel has been bared at this point.

Also, an adherent deposit of copper on part of the test specimen which has been subjected to accidental damage by rubbing or mechanical deformation should not be taken into account.

Lastly, if there is any doubt as to the true nature or adhesion of the deposit, a fresh test may be carried out on another test specimen taken from the same coil of wire.

TABLE 2. — **Mass of zinc deposited, expressed in grammes per square metre (g/m^2), and number of one-minute immersions**

Diameters of galvanized wires *		Galvanizing grade A		Galvanizing grade B	
millimetres		Minimum mass of zinc g/m^2	Number of immersions	Minimum mass of zinc g/m^2	Number of immersions
from (including)	to (excluding)				
$^{45}/_{100}$	$^{5}/_{10}$	75	$^{1}/_{2}$	40	no test
$^{5}/_{10}$	$^{6}/_{10}$	90	$^{1}/_{2}$	50	no test
$^{6}/_{10}$	$^{8}/_{10}$	110	1	60	$^{1}/_{2}$
$^{8}/_{10}$	$^{10}/_{10}$	130	1	70	$^{1}/_{2}$
$^{10}/_{10}$	$^{12}/_{10}$	150	$1^{1}/_{2}$	80	1
$^{12}/_{10}$	$^{15}/_{10}$	165	$1^{1}/_{2}$	90	1
$^{15}/_{10}$	$^{19}/_{10}$	180	2	100	1
$^{19}/_{10}$	$^{25}/_{10}$	205	2	110	$1^{1}/_{2}$
$^{25}/_{10}$	$^{32}/_{10}$	230	$2^{1}/_{2}$	125	$1^{1}/_{2}$
$^{32}/_{10}$	$^{40}/_{10}$	250	3	135	2

* Before removal of the zinc coating.

6. SIMPLE TORSION TEST

6.1 General

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The test should be carried out according to ISO Recommendation R 136, *Simple Torsion Testing of Steel Wire.*

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If a simple torsion test has to be carried out on steel wires of nominal sizes smaller than 0.5 mm, destined for shipbuilding, this test should also be made according to ISO Recommendation R 136.

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6.2 Procedure

The test specimen should be subjected to a constant tensile force proportional to the tensile strength of the wire tested (2 per cent rounded to ½ kgf above).

Contrary to ISO Recommendation R 136 the length between grips of the test specimen, consisting of a piece of wire destined for steel wire ropes, should always be 100 times the diameter of the wire.

Table 3 shows, in terms of the wire diameters and of their tensile strength, the minimum number of turns required; for wires taken from the wire rope, this number is reduced by 10 per cent (rounded to the lower whole number).

TABLE 3. — **Minimum number of turns required**

Diameters of wires		Galvanizing grade A		Galvanizing grade B	
millimetres		Wires of 140 to 159 kgf/mm² (89 to 101 tonf/in²) (1375 to 1560 N/mm²)	Wires of 160 to 179 kgf/mm² (101.5 to 114 tonf/in²) (1570 to 1755 N/mm²)	Wires of 140 to 159 kgf/mm² (89 to 101 tonf/in²) (1375 to 1560 N/mm²)	Wires of 160 to 179 kgf/mm² (101.5 to 114 tonf/in²) (1570 to 1755 N/mm²)
from (including)	to (excluding)				
$^{10}/_{10}$	$^{13}/_{10}$	15	15	27	25
$^{13}/_{10}$	$^{23}/_{10}$	15	14	26	24
$^{23}/_{10}$	$^{30}/_{10}$	14	12	23	21
$^{30}/_{10}$	$^{40}/_{10}$	12	10	21	20