UPDATED STATUS OF THE INTERNATIONAL STANDARDIZATION OF ELEVATOR ROPES

Dr.-Ing. Michael Molkow
Drahtseilerei Gustav Kocks, Germany

Keywords: Elevator rope, lift rope, EN–Standard, ISO 4344

ABSTRACT

The European CEN lift rope draft Standard, ready for Formal Vote as well as the draft Standard ISO / CD 4344 are covered. Both Standards have been developed in a cooperation of the respective working groups. As the Standards / drafts are now in quick progress, the paper will show the status at April 2001, whilst in Singapore the very actual status of these Standards will be presented.

1. Introduction:

Statement: The timetables and lists of contents, especially of the Draft ISO 4344 were only actual in April 2001, when this paper was in preparation. Possible changes depend on the number and volume of comments, which will arrive from all interested parties, when the ISO DIS draft is published.

For the interpretation of Standards, some remarks are necessary in advance:

- A Standard often gives only the minimums for requirements, measurements and performances.
  Example: Minimum breaking force value of a rope in the Standard and higher value in the catalogues of the manufacturers.
- Products with better values than required are also within the Standard, provided, they are within the scope and all the other safety requirements are met.
- The purpose of EN – Wire Rope Standards is in first order SAFETY against those hazards, which are listed in the Machinery Directive.
- So, satisfying economical performance depends far more on where and how the rope is applied.
- Any safety requirement (and there are only safety related requirements f.i. in the EN – wire rope Standards) must have its matching verification.
- If a manufacturer has installed an independently verified quality system acc. EN ISO 9002, this will be taken into consideration in some of the verification – clauses.
- It is not allowed to have in the normative parts of a new European or new ISO – Standard inch–sizes or non–SI – units, but it is possible and advisable, to give guidance on conversions and replacements etc. in the informative Annexes of such Standards.

- A Standard shall never be a barrier against innovation. So, when a product is not mentioned in the tables f.i. in a Standard for elevator ropes, you are allowed to use also other rope constructions etc. for this application, providing, all the other, especially safety requirements of the Standard are met. A Standard makes it only easier to order, to supply and to get approval from the authorities.
- An harmonised European Standard is totally different in his force and consequences from the now existing older National and International Standards, when being applied within the Common Market of the EU.

2. The actual time table of the EN and ISO Lift Rope Standards

2.1 The European Rope Standards are divided in Parts:

Headline: Steel Wire ropes – Safety

Part 1: General requirements
Part 2: Definitions, designation and classification
Part 3: Specification for information for use and maintenance to be provided by the manufacturer
Part 4: Stranded ropes for general lifting applications
Part 5: Stranded ropes for lifts
Part 6: Stranded ropes for mine shafts
Part 7: Locked coil ropes for mine shafts
Part 8: Stranded hauling and carrying-hauling ropes for cableways and aerial ropeways designed to carry persons and materials
Part 9: Locked coil carrying ropes for cableways and aerial ropeways designed to carry persons and materials.
Part 10: Spiral ropes for general structural applications

The updated timetable is now the following:

Responsible is CEN TC 168 WG 2, Secretary BSI

Part 1: Formal vote starting 04/2001
Publication as EN Standard approx. 12/2001

Part 5: Formal vote starting 04/2001
Publication as EN Standard approx.12/2001

2.2 International (ISO) draft Standard ISO / CD 4344

Responsible is ISO TC 105 WG 3, Secretary BSI
Circulation of the draft as ISO / CD 4344 has finished.
Publication as ISO – Standard approx. 12/2002.

3. The contents of the European Lift Rope Standard:

3.1 General:

Parts 1 to 3 are valid for all the other Parts. They are all planned to become Harmonised EN Standards. The background for these papers is the Machinery Directive (MD) and the Lift Directive (LD). So these Standards are not any more such contractual Standards as the older ISO – Standards and the older DIN–Standards, which often ask for negations and agreements between supplier and purchaser. These new European Harmonised Standards are only meant to bring a product into the Common Market.

When the manufacturer has produced his lift rope acc. to the requirements of Part 1 and 5, it is assumed, that his product covers the safety requirements of the MD and LD, which both are LAWS. So no deviation from the Safety Requirements of these Standards is possible, when the manufacturer wants to remain under the umbrella of an Harmonised Standard. When modifications on the product are required by a possible user, and when by that some Safety Requirements of the Standard are now not achievable, the manufacturer has to demonstrate himself, that his product is within the requirements of MD and LD.

3.2 Contents, especially new contents in detail:

The Lift Rope Standard is based on the ISO Standards 2408 and 4344, with their rope classes and the idea of an average Minimum Breaking Force within a class. For example: the rope class 8 x 19 + fibre core covers 8 x 19 Seale, 8 x 19 Warrington and 8 x 19 Filler, each with fibre core, and shows in the table per diameter one (1) value for the Minimum Breaking Force, one value for the unit weight and one value for the metallic area factor.

In Detail:

The European Lift Rope Standard will presumably cover:

- as rope applications:
  - Suspension ropes
  - Governor ropes
  - Compensating ropes

- as rope grades:
  - dual tensile 1180 / 1770, 1370 / 1770, 1570 / 1770
  - single tensile 1570, 1770

- as rope cores materials:
  a) fibre
  b) steel, as an independent wire rope (IWRC)
  c) steel based composite e.g. steel plus fibre, steel plus polymer
  d) non metallic cores other than only fibre.

- as rope constructions:

  With tables for minimum breaking forces etc.:

  class 6 x 19 + fibre core
  class 8 x 19 + fibre core
  class 8 x 19 + steel core (IWRC)
  class 6 x 36 + fibre core (compensating ropes only)

  but allowing also other rope constructions.

  As an example Table 1 shows one of the tables of the final vote version of prEN 12385 – 5, status 02/2001.

- as rope diameter tolerance fields:

  for fibre core ropes (traction)
  for steel core ropes (traction)
  for ropes for roped hydraulic lifts and
  for compensating duties.

prEN 12385-5:2001

Table 1 — Class 8 x 19 with steel core for suspension duty

Construction cross section examples	Construction of rope		Construction of strand	
	Item	**Quantity**	**Item**	**Quantity**
Figure being prepared 8×19S-IWRC	Strands outer strands layers of strands Wires in rope	8 8 1 152 to 232	Wires Outer wires Layers of wires	19 to 29 9 to 14 2

Construction cross section examples	Typical examples		No. of outer wires		Outer wire factor[1)]
	Rope	**Strand**	**Total**	**per strand**	
Figure being prepared 8×25F-IWRC	8×19 S	9-9-1	72	9	0,0655
	8×25 F	12-6F-6-1	96	12	0,0525
	8×19 W	6+6-6-1	96	12 · 6 6	0,0606 0,0450

Construction cross section examples		
Figure being prepared 8×19W-IWRC	Min. breaking force factor Nominal length mass factor[1)]: Nominal metallic area factor[1)]:	K_2 = 0,356 W_2 = 0,407 C_2 = 0,457

Nominal rope diameter	Approximate nominal[1)] length mass[1]	Minimum breaking force (kN)			
		Dual tensile		Single tensile	
mm	kg/100 m	Rope grade 1370/1770	Rope grade 1570/1770	Rope grade 1570	Rope grade 1770
8[2)]	26,0	35,8	37,4	35,8	40,3
9	33,0	45,3	47,3	45,3	51,0
10[2)]	40,7	55,9	58,4	55,9	63,0
11[2)]	49,2	67,6	70,6	67,6	76,2
12	58,6	80,5	84,1	80,5	90,7
13[2)]	68,7	94,5	98,7	94,5	106
14	79,8	110	114	110	124
15	91,6	126	131	126	142
16[2)]	104	143	149	143	161
18	132	181	189	181	204
19[2)]	147	202	211	202	227
20	163	224	234	224	252
22[2)]	197	271	283	271	305

[1)] Informative only

[2)] Preferred sizes.

For intermediate rope diameters also methods and formulas to calculate the respective values of unit weight, metallic area, minimum breaking force and diameter of outer wire are provided.

4 The presumable contents of the ISO Standard Ropes for Lifts

4.1 General

The existing ISO 4344 is more or less a "European" International Standard describing the European lift rope scenery 18 years ago. Some bigger lift manufacturers took parts of it as guidance into their own work Standards. At the time, when this Standard was established for the first time, a true International Standard was still not necessary. When a big lift company supplied an elevator somewhere in the world far away from Headquarter, it came with machine, calculation, controllers and mostly ropes. So only work Standards were necessary.

But now, with easy communication worldwide and an elevator today being a jigsaw puzzle made of parts from global sourcing, an International Standard is necessary. In general, EN and ISO lift rope Standards shall and will be very similar, with the ISO Standard covering some more variations. The ISO Standard will anyway be bigger in volume, because it has to cover also those requirements, which for the EN Standard are within Part 1.

4.2 General Problems in creating an applicable International rope Standard:

- Lifts started in history as all other machines as nationally produced items. But in difference to "normal machines" they are not movable, so they remained local under local control. There was no need for the manufacturers, to produce according other than National Standards.
- This leads to local special solutions, often dependent on circumstances and the possibilities of the local manufacturers.
- Now there are 100 thousands of installed units of special design in each nation, which need replacement some day. No standardiser would dare, to make a Standard not covering such specialities, or his new Standard would not even be read in the respective Nation.

4.3 Some special problems

- Problems with rope diameters:
  A lot of Nations have different preferred and even different legally allowed minimum diameters. Table 2 shows some of them.

Table 2: Nation – dependent preferred rope diameters

Country	suspension rope diameter	
	preferred	legal minimum
France	10	8
Germany	13	8
UK	11	8
USA	1/2" = 12,7 cm	3/8" = 9,5 mm
Japan	12	Code says 10, allowed is 8

Here additionally the problem of inch-sizes versus metric sizes exists. Replacement of 5/8" by 16 mm would be no difficulty, replacing of 1/2" by 13 mm only is possible by extreme accuracy of the ropemaker and 3/8" is not at all 10 mm. And there are also 5/16", 7/16", 9/16", 13/16" existing as lift rope diameters, at least for replacement. Table 3 lists the variety of diameters. The recommendation of the Standard for preferred diameters for new lifts is marked with [2)].

Table 3: List of existing lift rope diameters

8[2)]	in Europe and Japan smallest suspension rope, very common, is also 5/16"
9	existing, but not very common
9,5	3/8" USA's smallest suspension rope
10[2)]	very common around the world
11[2)]	common in Europe
11,1	7/16" USA, only replacement
12	very common for Japan lift makers
12,7	1/2" very common also outside USA
13[2)]	very common around the world
14	very seldom, but existing
14,3	9/16" USA
15	existing, seldom
16[2)]	≈ 5/8" very common around the world
17,5	11/16" USA
19[2)]	3/4" and common in Europe
20	existing, seldom
20,6	13/16" USA
22[2)]	existing, seldom
22,2	7/8" USA

- Problems with rope grades

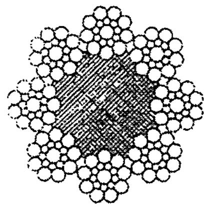
  In this field the wide world of nationally deviating technical history is obvious, see Table 4:

Table 4: Some Nation – dependent rope grade specialities

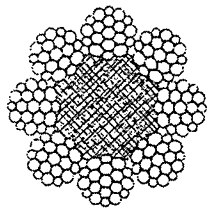
Nation	national rope grade name	Type	outer wire N/mm^2	inner wire N/mm^2
Europe	1370/1770	dual tensile	1370	1770
France Germany UK	1570 1770	single tensile single tensile	1570 1770	1570 1770
UK	1180/1770	dual tensile	1180	1770
USA	Traction Steel	dual tensile	approx. 1180 not defined	approx. 1770 not defined
	extra high strength Traction Steel	dual tensile	approx. 1570 not defined	approx. 1770 not defined
	IRON	dual tensile	approx. 700 not defined	approx. 1180 not defined
Japan	Grade E	dual tensile	1320 defined	1620 not defined
	Grade A	single tensile	1620	1620

Table 5 : Lift rope class 8 x 19 with fibre core of bright or zinc coated (Quality B) wire

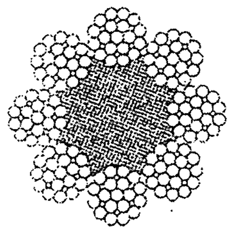
Construction cross section example



8 x 19 Seale + fibre core



8 x 19 Warrington + fibre core



8 x 25 Filler + fibre core

Construction of rope		Construction of strand	
Item	Quantity	Item	Quantity
Strands	8	Wires	19 to 25
Outer strands	8	Outer wires	9 to 12
Layers of strands	1	Layers of wires	2
Wires in rope 152 to 200			

Typical examples		No. of outer wires		Outer wire factor[1] a
Rope	Strand	Total	per Strand	
8 x 19 S	9-9-1	72	9	0,0655
8 x 19 W	6+6-6-1	96	12 6 6	0,0606 0,0450
8 x 25 F	12-6F-6-1	96	12	0,0525

Min. breaking force factor	$K_1 = 0.293$
Length mass factor[1]	$W_1 = 0.340$
Metallic area factor[1]	$C_1 = 0{,}349$

Nominal rope diameter	Approximate mass[1]	Minimum breaking force (kN)						
		Dual tensile				Single tensile		
mm	kg/100 m	Rope grade 1180/1770	Rope grade 1320/1620	Rope grade 1370/1770	Rope grade 1570/1770	Rope grade 1570	Rope grade 1620	Rope grade 1770
8[2]	21,8	25,7	26,5	28,1	30,8	29,4	30,4	33,2
9	27,5	32,5	–	35,6	38,9	37,3	–	42,0
9,5	30,7	36,2	37,3	39,7	43,6	41,5	42,8	46,8
10[2]	34,0	40,1	41,3	44,0	48,1	46,0	47,5	51,9
11[2]	41,1	48,6	50,0	53,2	58,1	55,7	57,4	62,8
12	49,0	57,8	59,5	63,3	69,2	66,2	68,4	74,7
12,7	54,8	64,7	66,6	70,9	77,5	74,2	76,6	83,6
13[2]	57,5	67,8	69,8	74,3	81,2	77,7	80,2	87,6
14	66,6	78,7	81,0	86,1	94,2	90,2	93,0	102
14,3	69,5	82,1	–	–	98,3	–	–	–
15	76,5	90,3	–	98,9	108	104	–	117
16[2]	87,0	103	106	113	123	118	122	133
17,5	104	123	–	–	147	–	–	–
18	110	130	134	142	156	149	154	168
19[2]	123	145	149	159	173	166	171	187
20	136	161	165	176	192	184	190	207
20,6	144	170	–	–	204	–	–	–
22[2]	165	194	200	213	233	223	230	251

[1] Informative only, see also Annex C

[2] Preferred sizes for new lifts

4.4 Presentation of possible solutions.

In Table 5 some of the proposals in the draft Standard, for the diameter and rope grade problems are shown.

4.4.1 Solutions for the diameters:

There are preferred diameter sizes marked, to give guidance for future installation and modernisation. The most common National and especially International inch – sizes are covered by very nearby metric sizes with the only small bad luck of some uneven millimetre sizes.

In an informative Annex (inch–sizes and other non–SI – units can only be mentioned in the informative Annexes of an ISO Standard) there are shown the inch–sizes, some National special rope grades and minimum breaking forces and –important– which ropes of the normative tables could replace sufficiently certain National ropes.

4.4.2 Solutions for rope grades

It was mentioned before: every Nation should find its National mainly used items in such a Standard, or the Standard will not be applied. One of the results of this philosophy is the high number of listed rope grades in Table 4, some of them leading to very similar rope breaking forces. But this idea enables for the first time people to compare or to replace items, used on opposite sides of the world. It also shows people some new items with the authority and proven safety of an International Standard.

It will take time and possibly some future revisions of the Standard to reduce the number of rope grades down to the few really necessary ones. Some small problems are still not solved: the tensile strength of the wires in Grade E and A have no upper limit in the respective National rope Standard and for the US lift rope grades there are different definitions through the country . And there is also the fact, that some manufacturers are not accustomed to Standards at all.

5. Summary

The new Standards will document technical progress, f.i. by tables for ropes with steel core and by covering governor and compensating ropes also. But as most of the daily business of the lift industry is maintenance, replacement and modernisation, the user of a Standard for such long living machinery as lifts and ropes are, must find also his long time accustomed items in it. The Standard makers have taken this into account.

Biography:

After graduating in Mechanical Engineering, he was several years member of the Wire Rope Research Institute at the University of Stuttgart, till he earned his doctorate in 1982. Title (translated): Traction Capacity of Drive Sheaves with hardened Vee – Grooves. He then joined Drahtseilerei Kocks (DRAKO) in Germany, where he later hold the position of the managing director. Retired since May 2000.