ACTUAL STATUS OF THE INTERNATIONAL STANDARDIZATION OF ELEVATOR ROPES

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ABSTRACT

The European Lift Rope Draft Standard as well as the recently established ISO work Item NP 4344 of ISO TC 105 WG 3 is covered. The valid ISO Standard 4344 does not even mention some of the most essential barriers against a real International Standard, as there are inch–metric sizes, modern rope constructions and very different tensile strength grade ideas throughout the respective national elevator industries. These and other fields of problems, solved and still not solved ones are presented and the logic behind some of the proposed solutions is described.

1. Introduction:

Statement: This paper was only actual, i.e. up to date, in January 2000, when being prepared. As the EN and ISO Lift Rope Standards are now progressing hopefully very quick, there could be an update in May necessary.

How to interpret a standard seems not to be so easy, or standardizers would not have to fight all the time against the very same misinterpretations.

Some of the essentials about Standards need to be mentioned for better understanding:

- When a standard requires a minimum value of a certain mechanical property for a product, a product with a higher value than this minimum is also within the standard, providing, all the other requirements of the standard are met.
  Example: Minimum breaking force of a rope and higher value in the catalogue of the manufacturer.
- 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.
- 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 to give guidance on conversions and replacements etc. in the informative Annexes of such Standards is possible and also advisable.

- An harmonized European Standard is totally different in his force and consequences from the now existing older National and International Standards.

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

2.1 The European Rope Standards are devided 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 maintenace 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 hoists
Part 7: Locked coil ropes for mine shafts
Part 8: Stranded hauling and carrying-hauling ropes for cableways for the transportation of passengers
Part 9: Locked coil carrying ropes for cableways for the transportation of passengers
Part 10: Spiral ropes for general structural applications

The timetable is the the following:

Responsible is CEN TC 168 WG 2, Secretary BSI

Part 1: Formal vote will be approx. 01/2000

Publication as EN Standard approx. 03/2001

Part 5: Formal vote will be approx. 12/2000

Publication as EN Standard approx.09/2001

2.2 International (ISO) Standard Project NP 4344

Responsible is ISO TC 105 WG 3, Secretary BSI
Non – optimistic time table
In one year: ISO/DIS 4344 circulated
In 10/2002 publication as ISO – Standard. (optimistic: 12/2001)

3. The presumable contents of the European Lift Rope Standard:

3.1 General:

Both, Part 1 and 5 will be harmonized 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 our older DIN and ISO --Standards, which often ask for negatiations and agreements between supplier and purchaser. These new European harmonized standards are only ment 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 negation about the Safety Requirements of these Standards is possible, when the manufacturer wants to remain under the umbrella of an harmonized Standard. When modifications on the product are realy necessary, and when then some

Safety Requirements of the standard are 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 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) Minimum Breaking Force, one unit weight and one metallic area.

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 independant wire rope (IWRC)
  c) steel based composite e.g. steel plus fibre, steel plus polymer
  d) non metallic cores other than only fibre.

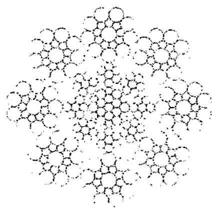
- as rope constructions:
  With tables for minimum breaking forces etc.:
  class 6 x 19 + fibre core
  class 8 x 19 + fibre core
  class 8 x 19 + steel core (IWRC)
  class 6 x 36 + fibre core (compensating ropes only)
  but allowing also other single layer or parallell closed rope constructions, but having no less than 6, nor more than nine outer strands,
  and allowing also other constructions with internal linear wire contact between outer and inner strands.

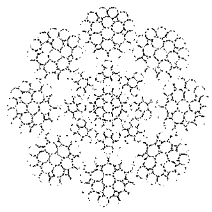
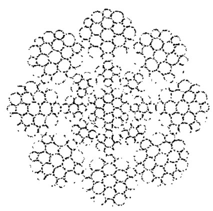
  As an example Table 1 shows one of the tables of a revisioned version of prEN 12385 – 5, status January / February 2000.

- 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.

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

Table 1 Class 8 x 19 with steel core (intermediate version of prEN 12385-5) of bright or zinc coated (quality B) wire

Construction cross section example	Construction of rope		Construction of strand	
	Item	**Quantity**	**Item**	**Quantity**
 8 x 19 S-CWR	Strands	8	Wires	19 to 29
	Outer strands	8	Outer wires	9 to 14
	Layers of Strands	1	Layers of wires	2
	Wires in rope	152 to 232		

Construction cross section example	Typical examples		No. of outer wires		Outer Wire factor[1)]
	Rope	**Strand**	**Total**	**per Strand**	
 8 x 25 F-CWR	8x19 S	9-9-1	72	9	0,0655
	8x25 F	12-6F-6-1	96	12	0,0525
 8 x 19 W-CWR	8x19 W	6+6-6-1	96	12 6	0,0606
				6	0,0450

Min. breaking force factor $K_2 = 0,356$
Nominal length mass factor[1)]: $W_2 = 0,407$
Nominal metallic area factor[1)]: $C_2 = 0,457$

Nominal rope diameter	Appropriate mass[1)]	Minimum breaking force (kN)			
		Dual tensile		Single tensile	
mm	kg/100m	Rope grade 1370/1770	Rope grade 1570/1770	Rope grade 1570	Rope grade 1770
8[2)]	26,0	35,8	38,0	35,8	40,3
9	33,0	45,3	48,2	45,3	51,0
10[2)]	40,7	55,9	59,5	55,9	63,0
11[2)]	49,2	67,6	71,9	67,6	76,2
12	58,6	80,5	85,6	80,5	90,7
13[2)]	68,7	94,5	100	94,5	106
14	79,8	110	117	110	124
15	91,6	126	134	126	142
16[2)]	104	143	152	143	161
18	132	181	193	181	204
19[2)]	147	202	215	202	227
20	163	224	238	224	252
22[2)]	197	271	288	271	305

[1)] Informative only [2)] Preferred sizes

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. 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 a work standard was 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 nationaly produced items. But in difference to "normal machines" they are not movable, so they remained local under local control.
- As local machines for everybody's use they have been all the time in the focus of national (or even local) authorities and bureaucracy, which loaded and load the elevator with extreme, very often locally different, safety requirements.
- Especially the properties of lift ropes as there are preferred diameters, rope grades, rope constructions and amount of lubricant develloped often by chance and also according to the possibilities of the resident rope industry.
- When such a system has been establiched nationally for some 50 years, it is nearly impossible to change single items in such a system. Explanation: in a lift, machines + controller + traction/ pressure/ rope safety calculation + sheave size + sheave quality + sheave groove type + rope lubrication + wire tensile strength grade + installation technics + maintenance habbits form now a longtime approved and interdependent system. If you change now one item, what will happen? Additional there are now 100 thousands of installed units nationwide, which need replacement some day. No standardizer 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 legaly allowed minimum diameters. Table 2 shows some of them.

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 ropemarker 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.

Table 2: Nation – dependent preferrred 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

- Problems with rope grades

  In this field the wide world of nationally deviating technical history is obvious, see Table 3:

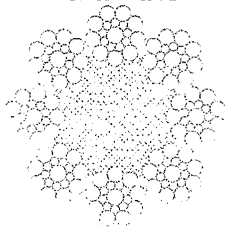
Table 3: Some Nation – dependent rope grade specialities

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	ca.1180 not defined	ca. 1770 not defined
	extra high strength Traction Steel	dual tensile	ca. 1570 not defined	ca. 1770 not defined
	IRON	dual tensile	ca. 700 not defined	ca. 1180 not defined
Japan	Grade E	dual tensile	1320 defined	1620 not defined
	Grade A	single tensile	1620	1620

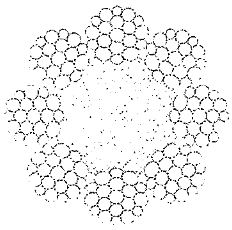
4.4 Presentation of possible solutions.
In Table 4 some presumable solutions for the diameter and rope grade problems are shown.

Table 4: Class 8 x 19 with fibre core

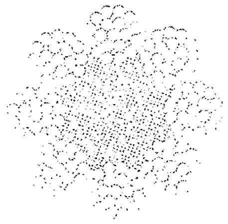
Construction cross section example



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 29
Outer strands	8	Outer wires	9 to 14
Layers of strands	1	Layers of wires	2
Wires in rope	152 to 232		

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 25 F	12-6F-6-1	96	12		0,0525
8 x 19 W	6+6-6-1	96	12	6	0,0606
				6	0,0450

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 1320/1450	Rope grade 1370/1770	Rope grade 1570/1770	Rope grade 1570	Rope grade 1620
8[2]	21,8	25,7	26,4	28,1	30,8	29,4	30,4
9	27,5	32,5	33,5	35,6	38,9	37,3	38,4
9,5	30,7	36,2	37,3	39,7	43,6	41,5	42,8
10[2]	34,0	40,1	41,3	44,0	48,1	46,0	47,5
11[2]	41,1	48,6	50,0	53,2	58,1	55,7	57,4
12	49,0	57,8	59,5	63,3	69,2	66,2	68,4
12,7	54,8	64,7	66,6	70,9	77,5	74,2	76,6
13[2]	57,5	67,8	69,8	74,3	81,2	77,7	80,2
14	66,6	78,7	81,0	86,1	94,2	90,2	93,0
15	76,5	90,3	93,0	98,9	108	104	107
16[2]	87,0	103	106	113	123	118	122
18	110	130	134	142	156	149	154
19[2]	123	145	149	159	173	166	171
20	136	161	165	176	192	184	190
22[2]	165	194	200	213	233	223	230

[1] Informative only, see also Annex C

[2] Preferred sizes

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 millimeter 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, the 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 would 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 possibility some revisions of the Standard to reduce the number of rope grades down to the few realy necessary ones. One problem still not solved is the fact that 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 .

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 longtime accustomed items in it.

Biography:

After graduading 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.