

DEPARTMENT OF MINES AND RESOURCES
BUREAU OF MINES
CANADA

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Ottawa, July 4, 1946.

R E P O R T
of the
ORE DRESSING AND METALLURGICAL LABORATORIES.
Investigation No. 2073.

Examination of Mine Hoisting Steel Cable
(18 x 7, Non-Rotating Construction).

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Source of Material and Object of Investigation:

Under date of June 15, 1946, Mr. Alex. Stewart, Field Manager, Century Mining Corp., Ltd., Cranberry Portage, Manitoba, submitted a sample 6-ft. length non-rotating construction type of mine hoisting cable. In a letter accompanying the material, it was stated that "the Manitoba Mines Inspector, Mr. Gobert, has just completed an examination of our operation, and has requested certification of this cable, and has specified that it shall be of the non-rotating type, and shall conform to the proper standards of tensile strength, etc., commonly required in mining operations."

The cable was received in these Laboratories on June 28, 1946, and was tested to Canadian Engineering Standards Specification No. 4, 1921, for Wire Rope for

(Source of Material and Object of Investigation cont'd) -

Mining, Dredging and Steam Shovel Purposes.

Rope Construction:

The cable submitted consisted of 12 outer and 6 inner strands, each strand containing 6 outer wires and one core wire, the outer strands being regular lay (right) and the inner strands Lang's lay (left) construction layed around a hemp core.

Diameter Measurements:

The diameters of the wires in the outer and inner strands were measured with a micrometer gauge, samples being taken from each of the 18 strands. The following readings were obtained:

<u>Outer Strands</u>	<u>Diameter, in inches</u>
6 outer wires	0.056
1 inner wire	0.060
<u>Inner Strands</u>	
6 outer wires	0.056
1 inner wire	0.060

The diameter of the rope, as measured over its extreme outside wires, was found to be 0.875 inch.

Tensile Tests:

Samples of the wires, taken from outer and inner strands, were tested in the Baldwin-Southwark tensile testing machine, the wires being held in Templin wedge-type grips. The same rate of loading was used in all tests. The table on the following page gives the values obtained.

(Table on Page 3)

(Tensile Tests, cont'd) -

Outer Strands

<u>Strand No.</u>	<u>Dia. of Wire, inches</u>	<u>Break (pounds)</u>	<u>Ultimate Stress, p.s.i.</u>
1	0.056	646	269,000
2	"	630	263,000
3	"	624	260,000
4	"	612	255,000
5	"	616	257,000
6	"	622	259,000
7	"	640	267,000
8	"	616	257,000
9	"	630	263,000
10	"	628	261,000
11	"	614	256,000
12	"	620	258,000
Core Wire	0.060	722	258,000

Inner Strands

<u>Strand No.</u>	<u>Dia. of Wire, inches</u>	<u>Break (pounds)</u>	<u>Ultimate Stress, p.s.i.</u>
1	0.056	535	244,000
2	"	620	258,000
3	"	532	222,000
4	"	610	254,000
5	"	540	225,000
6	"	532	222,000
Core wire	0.060	698	249,000

Wire Rope:

A full section of the cable was mounted in two steel holders with zinc and tested in tension in a Rhielo 150,000-pound tensile testing machine in the Dept. of Public Works Mechanical Testing Laboratories, West Block, Ottawa, Ontario, under the direction of Mr. Lucas, the tests being witnessed by two members of the Physical Metallurgy Research Laboratories staff, Bureau of Mines. The distance between holders was 49 5/8 inches.

Six of the outer strands of the cable broke about four inches below the upper holder under a load of 58,720 pounds.

Torsion Tests:

The tests were carried out as follows: One end of the wire was attached to a stationary clamp provided with a special set of gears upon which was mounted a counter for measuring the number of turns. The other end was attached to a clamp which was free to move longitudinally. To a wire on this clamp was attached a wire which ran over a pulley. A weight was attached to this wire which applied a tension of 5,000 pounds per square inch on the wire. The length of the wire between clamps was ten inches. The number of complete turns of 360° required to rupture the wires was recorded. From this value the number of turns per length of 100 diameters for the two sizes of wires in the 18 strands was calculated.

Summary of Torsion Tests

Outer Strand

<u>Strand No.</u>	<u>Dia. of Wire, inches</u>	<u>Turns per length of 100 diameters</u>
1	0.056	33.2
2	"	34.8
3	"	25.8
4	"	29.2
5	"	26.4
6	"	28.1
7	"	29.8
8	"	32.0
9	"	29.8
10	"	29.8
11	"	29.8
12	"	29.2
Core wire	0.060	35.0

Inner Strand

<u>Strand No.</u>	<u>Dia. of Wire, inches</u>	<u>Turns per length of 100 diameters</u>
1	0.056	25.1
2	"	34.3
3	"	30.3
4	"	30.1
5	"	30.3
6	"	34.8
Core wire	0.060	35.0

Chemical Analysis

The outer and core wires had the following chemical composition:

	<u>Outer Wires</u>	<u>Core Wire</u>
	<u>Per cent</u>	
Carbon	- 0.66	0.67
Manganese	- 0.78	0.60
Silicon	- 0.25	0.27
Sulphur	- 0.028	0.032
Phosphorus	- 0.012	0.022

DISCUSSION OF RESULTS:

Wire Diameters -

The Canadian Engineering Standards Specification gives the following permissible variation in wire diameters: the wire shall be cylindrical and smooth and its diameter shall be uniform to within +0.003 inch for wires below 0.064 inch.

No variation was observed in the two sizes of wires examined in the eighteen strands.

Rope Diameters -

It is specified that the diameter of the rope as measured over the extreme outer wires shall in no case be less than the nominal size and shall not exceed the same by more than 1/16 inch in ropes of diameter smaller than one inch.

The rope was found to measure exactly 0.875", there being no variation from the nominal diameter. The rope examined is of the non-rotating type and is not included in the list recognized as standard constructions for C.E.S.A. Standard Wire Rope. The construction, however, conforms to that of an 18 x 7 Non-Rotating Wire Rope described in a "Modern Wire Rope Digest," a publication of the American Chain and Cable Company, Inc., Wilkesbarre, Pa.

(Discussion of Results, cont'd) -

Tensile Tests -

It is specified that the ultimate tensile strength of the finished rope should in no case be less than that specified by the vendor. It is not known what strength was specified for this rope. The American Chain and Cable Company, Inc., gives the following breaking strength value for 7/8" diameter, 18 x 7 construction, non-rotating wire rope.

<u>Diam. of Rope, inches</u>	<u>Approx. Weight in lb./ft.</u>	<u>Breaking Strength, in pounds</u>			
		<u>Cast Steel</u>	<u>Mild Plow Steel</u>	<u>Plow Steel</u>	<u>Improved Plow Steel</u>
7/8	1.32	42,400	47,000	51,800	59,600

The rope broke under a load of 58,720 pounds.

It is also stated that the ultimate strength of the individual wires shall not be less than the value specified by the vendor in his tender and that their minimum strength be 220,000 p.s.i. (for best grade of special plow steel). The ultimate strength of all wires examined exceeded this specified minimum.

Torsion Tests -

The specification requires that the individual wires should withstand 25 complete turns per length of 100 diameters without breaking or showing any defect. Torsion tests on the outer and core wires from each of the 18 strands meet these requirements.

Chemical Composition -

The specification requires that the rope be made from acid open hearth steel containing more than 0.50 per cent carbon. The steels were found to have the specified carbon content. However, it is not possible to state by what process the steel was made.

Summary:

The cable examined was found to be a 18 x 7 non-rotating construction type of wire rope. The tensile strength of the individual wires conforms to Canadian Engineering Standards specification for special plough steel. The ultimate breaking strength is slightly less than the value published by the American Chain and Cable Company, Inc. for special plough steel. The torsion properties conform to the specification.

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