Surface Mining

haggie® Steel Wire Ropes for Open-Pit Mining

haggie®'s vast experience in the supply of ropes to open-cast mining operations, enables the Company to recommend and supply wire ropes which provide optimum performance.

Wire ropes for face shovels must be able to withstand repeated bending, shockloading and high radial pressures. Ropes used on **draglines** must also offer resistance to abrasion and plastic deformation.

haggie®
steel wire rope

Technical Aspects pertaining to Open-Pit Mining

Tolerance

(a Length

(i) General
<400 m: -0% and +4%
>400 m: -0% and 20 m for each 1000 m or part thereof

(ii) For matched sets of excavator ropes up to 95mm diameter the difference in length shall not exceed:
Length <150 m: 90 mm, or
Length >150 m: 90 mm +20 mm for each 30 m or part thereof.

(b) Mass

-7% and +0% based on the tables herein, which furnishes approximate masses for normally lubricated ropes.

(c) Diameter

The actual rope diameter shall be within the tolerance of –1% and +4%.

Measuring of rope diameter and lay

To find the correct diameter and lay length use the same method as for shaft mining ropes.

Percentage reserve strength

This is the ratio of the metallic area of all the inner wires to the total metallic area expressed as a percentage. This ratio is some what academic but will provide an indication of the ropes performance in severe applications.

Rope Construction	Percentage Reserve Strength
6x19(9/9/1)/IWRC	33%
6x25(12/6F+6/1)/IWRC	50%
6x36(14/7+7/7/1)/IWRC	57%
6x41(16/8+8/8/1)/IWRC	61%
6x49(16/8+8/8/8/1)/IWRC	61%
6x41C(16/8+8/8/1)/IWRC	61%
6x49C(16/8+8/8/8/1)/IWRC	61%
8x36(14/7+7/7/1)/IWRC	62%

Excavator Rope Selection

Selection Guide

Dragline and face shovel ropes are required to withstand fatigue caused by repeated bending, high radial pressures, and shock loading. In addition, drag ropes must offer resistance to abrasion and plastic deformation. The construction will invariably be a compromise between one which offers resistance to abrasion on the one hand, and resistance to bending fatigue on the other. A rope failure may cause not only downtime, but considerable damage could result. It is for this reason that it is vitally important to consider the correct rope selection. As with any type of equipment one must select the right rope for the right application. Different machine design characteristics, maintenance procedures, ground and operating conditions necessitate the selection of different rope constructions for optimum operating performance.

How to order rope

When ordering rope, if in any doubt as to your requirements, please contact Haggie® Technical Services Department.

A length of rope being manufactured – usually in lengths of 1000m

Wire Ropes For Draglines

Hoist & Drag Ropes

The same rope construction has commonly been used for hoists and drags, in the interest of stock rationalisation.

The present trend is to use the 6x49/IWRC construction as drags and the 8x36/IWRC as hoists.

Compared to the normal 6-strand ropes, the 8-strand configuration has the following advantages :–

- greater flexibility
- higher fatigue cycles
- lower bending stresses
- good wear resistance
- good resistance against crushing

The 8-strand construction uses approximately the same size outer wires as the 6-strand construction, thus the wear resistance is the same or better.

In general, as far as bending fatigue is concerned, the 8-strand rope is far superior to the 6-strand rope. In general the direction of Lay is Right Hand. Some users still consider the use of a Left and Right Hand pair of ropes on certain draglines to be advantageous. Practical experience to date has not shown any conclusive benefits.

New Developments

Although haggie® has extensive experience in rope plastication, a new line has been installed which will enable haggie® to plasticate ropes up to 160mm in diameter.

Thus, in the foreseeable future, haggie® will develop hoist ropes that are fully plasticated and drag ropes with “cushion cores” .

Advantages of Plastication

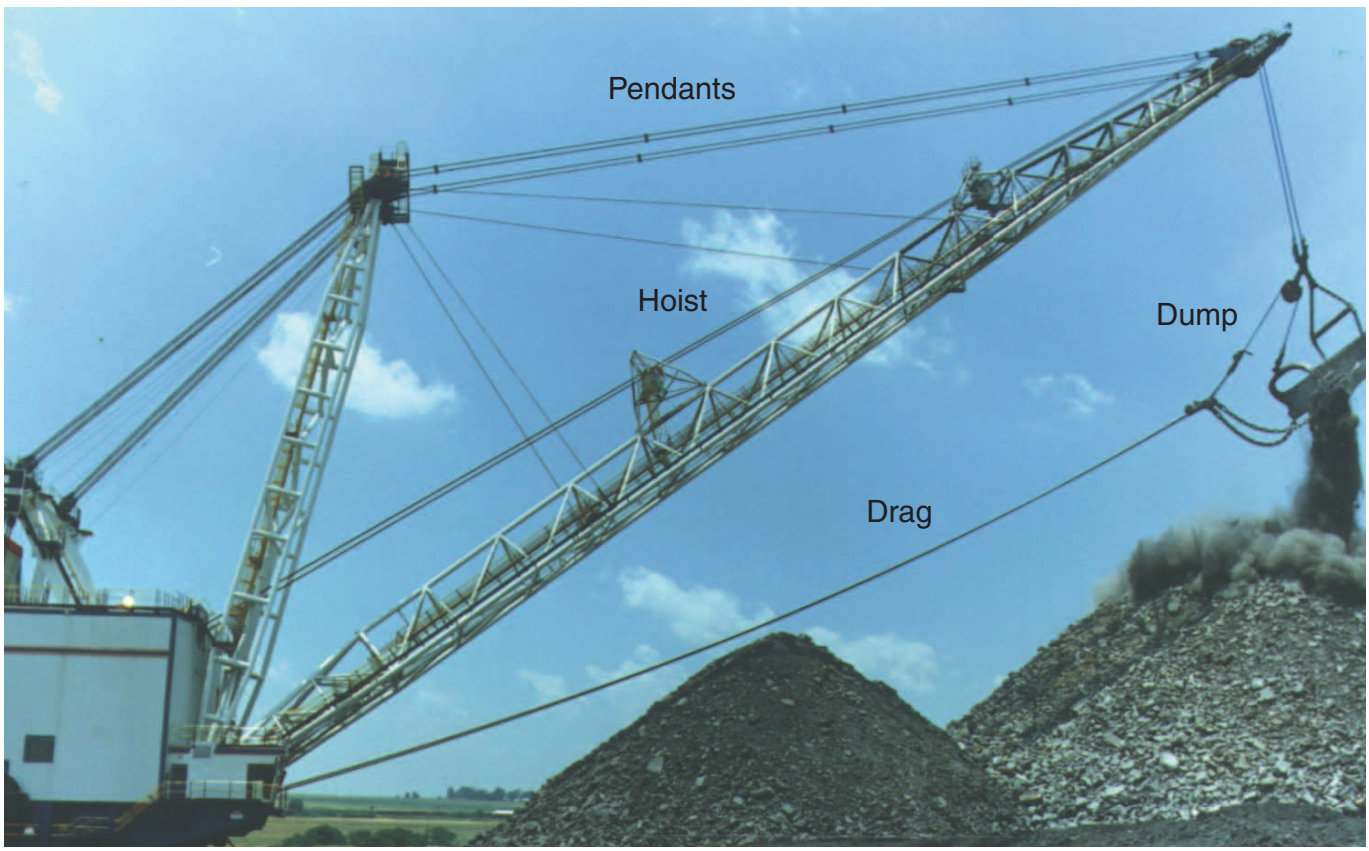
- reduces wear and rifling in the drum and sheave grooves
- keeps the lubrication within the rope and core, thus also keeping the machinery clean
- prevents the ingress of water, dirt etc.. into the rope
- prevents inter-strand and inter-layer nicking of outer wires

Boom Hoist Ropes

Recommended constructions are 6x49/IWRC for larger machines and 6x25/IWRC for smaller draglines.

Boom Pendants

Spiral bridge strand is generally recommended, although in some cases 6x25/IWRC suffices. haggie® spiral strands vary in size from 57mm to 98mm in diameter.



Wire Ropes for Draglines

The table below provides basic information on the type of ropes used on draglines.

Rope Type	Purpose	Recommended Rope Construction
Boom Hoist	Raises and lowers the boom for maintenance purposes	6x19/IWRC 6x25/IWRC 6x36/IWRC 6x41/IWRC 6x43/IWRC 6x49/IWRC
Pendants (Suspension)	Holds the boom and/or jury mast in their elevated positions under dynamic loadings	6x25/IWRC Spiral Strand
Hoist	Raises and lowers the bucket from the pit to the spoils bank and vice versa	6x19/IWRC 6x25/IWRC 6x36/IWRC 6x41/IWRC 6x43/IWRC 6x49/IWRC 8x36/IWRC 8x41/IWRC
Drag	Drags the bucket in the pit to load material	6x19/IWRC 6x25/IWRC 6x36/IWRC 6x41/IWRC 6x43/IWRC 6x49/IWRC 8x36/IWRC
Dump	Tips the bucket	6x25/IWRC 6x36/IWRC 6x41/IWRC
Safety	Provides an additional support for the jury mast	6x25/IWRC 6x36/IWRC 6x41/IWRC Spiral Strand

Wire Ropes for Face Shovels

Hoist Ropes

The most commonly used constructions (depending on bucket size and D/d ratios) are :–

- 6x25/IWRC
- 6x41/IWRC
- 6x43/IWRC
- 6x49/IWRC

Available in conventional and in compact strand.
The following sizes are also available plasticated :–

- 38mm, 44mm, 50mm – 6x41/IWRC
- 56mm – 6x49/IWRC

Crowd & Retract Ropes

Again depending on machine type, the following are recommended :–

- 6x25/IWRC for smaller capacity machines
- 6x36/IWRC for intermediate capacity machines
- 6x41/IWRC or 6x49/IWRC for larger capacity machines

Available in conventional and compact strand.

Boom Hoist/Boom Suspension Ropes

- 6x19/IWRC for smaller machines
- 6x25/IWRC for larger machines
- ridge strand for pendants on certain large machines.

Wire Ropes for Face Shovels

The table below provides basic information on the type of ropes used on face shovels.

Rope Type	Purpose	Recommended Rope Construction
Boom Hoist	Raises and lowers the boom for maintenance purposes	6x19/IWRC 6x25/IWRC
Pendants (Suspension)	Holds the boom in an elevated position under dynamic loadings	6x19/IWRC 6x25/IWRC Bridge Strand
Hoist	Raises and lowers the dipper	6x25/IWRC 6x41/IWRC 6x43/IWRC
Crowd/ Retract	Moves the sliding dipper sticks back and forth	6x25/IWRC 6x36/IWRC 6x41/IWRC
Trip	Opens the dipper door	6x19/IWRC 6x25/IWRC 6x36/IWRC

Installation, Inspection and Maintenance of Ropes for the Opencast Applications

Dragline/Excavator rope lives are dependant on factors including:

- Correct wire rope selection for the specific application.
- Proper handling, storage, installation and the correct maintenance of steel wire ropes.
- Types of overburden, interburden and more importantly the blast and size of the fragmentation achieved.
- Planned maintenance aspects relating to daily, weekly and monthly rope inspections, servicing and/or repairs being carried out as required.
- The depth of the excavation, (dragline ropes digging in a shallow pit for extended periods are prone to a short cycling of the ropes, resulting in an accelerated fatigue break-up over a shorter working length of the ropes in service.)
- The type of work being carried out by the dragline/excavator., viz. normal production, rehandling, or the type of chop down mode of excavation, will directly affect rope performance.
- Serviceability of the dragline/excavator hoist and drag drums, as well as all sheaves in all the sheave assemblies i.e. boom deflection, boom point and the fairlead sheave assembly.
- Competence, skill and moods of all dragline or excavator operators with respect to the overloading, shock loading and the general mishandling of wire ropes from time to time.

With all wire ropes – it is recommended that the maintenance teams involved begin taking the appropriate care and handling measures required with the ropes from the moment that the ropes are received on the mine from the rope suppliers.

Some of the factors which can adversely affect rope life and performance include:

- Bending of wire ropes over small diameter sheaves causes kinks and severe abrasion.
- Excessive vibration from damaged sheave bearings will result in premature fatigue type wire break-up failures.
- Sheaves that do not rotate freely, or the ropes sliding over or striking a stationery piece of equipment or obstruction, results in early wire failure.
- Abrasion causes work hardening and surface embrittlement of the outer crown wires of a rope (referred to as “Surface Martensite”).

Comprehensive advice on all aspects relating to dragline/excavator rope performance is provided to the Haggie Rand Technical Department.

1. Inspections

1.1 Sheaves

Ensure that all sheave grooves are within specification, or are machined prior to the installation of new ropes (i.e. the profiles of the sheave grooves should be uniformly machined to a plus tolerance of between 5 to 7,5 % of the nominal rope diameter.)

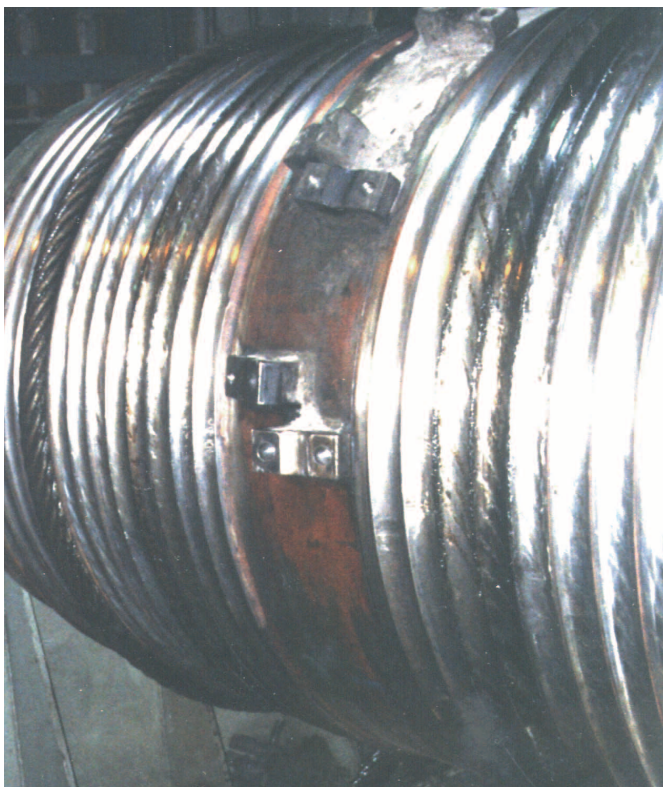
Ensure that all sheaves are correctly aligned and can rotate freely.

Tight or worn sheaves will adversely affect expected rope performances!!!

1.2 Drums

Drums should be carefully checked for the following:

(a) Rope indentations (rifling in the grooves).
(b) Undersized or worn grooves.
(c) Poor coiling resulting in the ropes jumping a groove.
(d) Loose or poor clamping of the ropes in the rope anchors.



1.3 Rope end terminations

Check that the drag and hoist sockets and/or wedges are not damaged or cracked when replacing ropes. The damaged socket and/or wedges will increase the risk of damage occurring to the rope itself. A poorly attached end fitting may result in the development of waviness throughout the rope and an inevitable premature failure of the rope.

1.4 Users Assessment of Rope Condition

The following points have been set out to assist the responsible person with his daily/weekly inspections:

- Plastic flow over rope length.
  If plastic flow is evident, check the sheave and drum grooves. These may be undersize and will cause broken wires due to fatigue. Heavy plastic wear early in the rope's life is an indication of undersized sheave grooves.
- Wear
  Generally speaking wear of outer wires will not seriously affect the rope's breaking strength unless accompanied by broken wires. Check for localised wear as this may indicate that the rope has jumped off a sheave or is running over or striking an object.
- Mechanical damage
  Irregularities caused by kinks, bends, or accidental damage can reduce the rope strength considerably. Care must be taken when installing ropes.
- Broken wires
  Remove broken wires as soon as they are discovered, in order to prevent damage to neighbouring wires.

2. Installation and Maintenance

2.1 When lifting the rope reels, care should be taken not to damage or to distort the reels, using a lifting or spreader beam.

Be very careful when releasing the rope ends from the reel as the rope is under tension. (Read the warning label on the reel.)

During installation, ropes should be paid out from the reel in a straight line without slack to prevent the possibility of kinking or disturbance to the lay of the rope.

It is essential to ensure that the reel does not overrun and some form of braking system should be applied. This braking should be applied to the reel only and not to the rope, as the reel will still tend to overrun if the braking is applied to the rope, to avoid the possibility of the rope slackening on the reel and becoming damaged.

It is recommended that steel reels fitted with a properly designed brake be used. This, apart from eliminating the risk of damage during handling, will speed up the installation process or procedure.

2.2 When a wedge socket is used, pressure from the rope strands imprint corrugations on the inside wall of the socket and or wedge, these ridges have a tendency to hold one or more strands tighter than the other strand in the rope when the rope takes up load, the result will be unbalanced loading on the rope, resulting in a “high strand” and possible failure. These indentations should therefore be removed periodically.

2.3 Break off any protruding broken wires to prevent damage occurring to crown wires on any of the adjacent strands as the rope operates. This is especially important for all ropes.

2.4 Rope life will be increased by installing the maximum possible rope length, so that the wear and indentation areas can be altered by pulling in systematically, resocketing and also end for ending at the correct time.

3. Operating Techniques

3.1 As previously stated the excavator operator has a major influence on rope performance and expected rope life, by minimising the damage due to falling rocks, excessive tensile shock loads and ensuring good maintenance practices.

3.2 Poor fragmentation may result in the excavator having to operate under particularly arduous conditions which will adversely affect rope performance and reduce the expected rope life. Hoist rope life will be extended by allowing the ropes to “bed down” during the first few cycles of the operation, this will be achieved by operating at reduced loads during the “bedding in period”.

3.3 Pulling the ropes through the overburden on the bank and/or over the edge of the pit will cause severe abrasion and this will markedly shorten the rope life.

3.4 THE DRAGLINE SHOULD STAND AS CLOSE TO THE PIT EDGE AS POSSIBLE.

This minimises the tendency or chance of pulling the ropes through the bank.

Open Pit Mining Rope Tables

Product Description

During the manufacturing process the completed strands are drawn through a die which has the effect of compacting the wires. Visually the rope appears to have been manufactured from flattened wire.

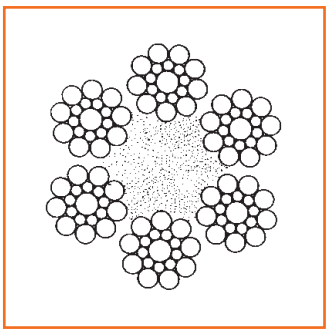
The result of this compacting is a wire rope of higher density which offers advantages over conventional ropes for certain applications.

Advantages include:

- Higher breaking strength for a given diameter. This feature enables users to specify smaller diameter ropes, or to lift increased loads.
- Improved surface contact. The compaction provides a smoother finish as the outer wires have been flattened. As a result the compacted ropes have greater resistance to abrasion while decreasing wear on sheaves and drums.
- Enhanced resistance to crushing. The reduction of internal voids and gaps enables the compacted ropes to withstand external forces to a greater degree.
- Increased fatigue endurance. Laboratory tests and field performance have shown that fatigue resistance is significantly increased.
- Longer service life. The benefits of Haggie Rand's compacted ropes ultimately mean greater rope life – thereby improving cost effectiveness.

Open Pit Mining Rope Tables:

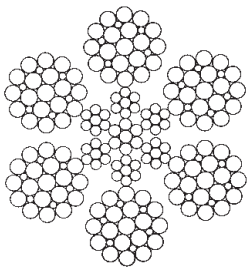
6x19(9/9/1)/IWRC



Nominal Rope Diameter (mm)	Estimated Mass (kg/m)	Estimated Breaking Force (Tensile Grade)		Outer Wire Diameter (mm)
		1600MPa	1800 MPa	
16,0	1,09	150	167	1,28
19,0	1,50	207	230	1,48
20,0	1,67	230	256	1,56
22,0	2,01	277	308	1,72
24,0	2,45	338	376	1,92
26,0	2,88	369	444	1,64
28,0	3,34	462	514	1,76
30,0	3,74	519	576	2,36
32,0	4,27	592	657	2,50
34,0	4,87	677	752	2,70

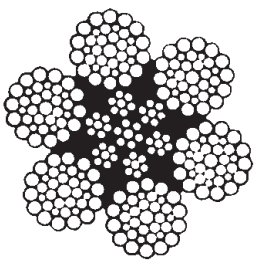
Open Pit Mining Rope Tables

6x25(12/6F+6/1)/IWRC



Nominal Rope Diameter (mm)	Estimated Mass (kg/m)	Estimated Breaking Force (Tensile Grade)		Outer Wire Diameter (mm)
		1600MPa	1800 MPa	
26,0	2,89	369	444	1,64
28,0	3,34	462	514	1,76
30,0	3,92	543	605	1,92
32,0	4,43	614	684	2,04
34,0	5,00	695	774	2,16
35,0	5,20	723	805	2,20
36,0	5,52	766	853	2,28
38,0	6,18	857	955	2,40
40,0	6,95	966	1076	2,55
41,0	6,95	966	1076	2,55
42,0	7,50	1042	1161	2,65
44,0	8,72	1215	1354	2,85
46,0	9,01	1255	1398	2,90
48,0	9,86	1375	1531	3,05
50,0	10,58	1477	1645	3,15
52,0	11,59	1618	1802	3,30
54,0	12,43	1737	1935	3,40
56,0	13,64	1904	2121	3,60
58,0	14,24	1987	2214	3,65
60,0	15,30	2131	2374	3,78

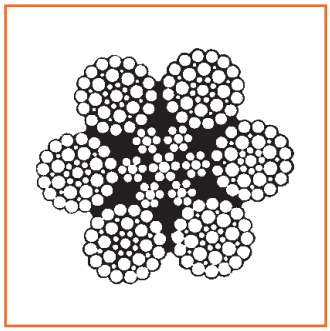
6x36(14/7+7/7/1)/IWRC



Nominal Rope Diameter (mm)	Estimated Mass (kg/m)	Estimated Breaking Force (Tensile Grade)		Outer Wire Diameter (mm)
		1600MPa	1800 MPa	
38,0	6,22	862	961	2,12
40,0	6,95	964	1075	2,24
42,0	7,72	1072	1196	2,36
44,0	8,69	1207	1345	2,50
46,0	9,08	1262	1407	2,55
48,0	10,05	1398	1559	2,70
50,0	10,82	1506	1679	2,80
52,0	11,66	1623	1809	2,90
54,0	12,62	1758	1960	3,00
56,0	13,60	1895	2113	3,15
58,0	14,61	2037	2271	3,25
60,0	15,20	2119	2362	3,25
64,0	17,78	2482	2768	3,60

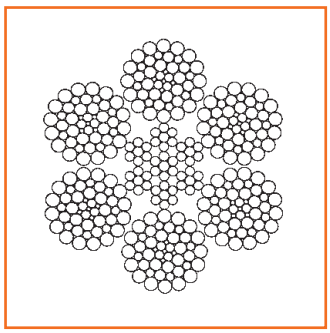
Open Pit Mining Rope Tables

6x41(16/8+8/8/1)/IWRC



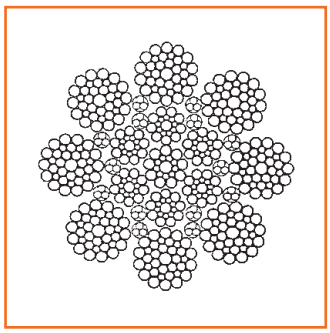
Nominal Rope Diameter (mm)	Estimated Mass (kg/m)	Estimated Breaking Force (Tensile Grade)		Outer Wire Diameter (mm)
		1600MPa	1800 MPa	
40,0	7,06	971	1081	2,00
42,0	7,67	1057	1177	2,08
44,0	8,83	1220	1357	2,24
45,0	8,83	1220	1357	2,24
46,0	9,15	1265	1408	2,28
48,0	10,16	1404	1563	2,40
50,0	11,00	1520	1692	2,50
52,0	11,93	1648	1834	2,60
54,0	12,83	1775	1975	2,70
56,0	13,75	1901	2115	2,80
58,0	14,78	2045	2276	2,90
60,0	15,64	2164	2408	3,00

6x49(16/8+8/8/4F+4/1)/IWRC



Nominal Rope Diameter (mm)	Estimated Mass (kg/m)	Estimated Breaking Force (Tensile Grade)	Outer Wire Diameter (mm)
		1700MPa	
50,0	10,77	1628	2,50
56,0	13,57	1917	2,80
60,0	15,44	2181	3,00
64,0	17,62	2673	3,20
70,0	21,08	2990	3,50
75,0	23,65	3395	3,74
80,0	27,75	3934	3,94
83,0	30,12	4517	4,14
85,0	31,18	4404	4,18
92,0	36,33	5149	4,58
95,0	38,66	5482	4,74

8x36(14/7+7/7/1)+8xP/6xP+IWRC

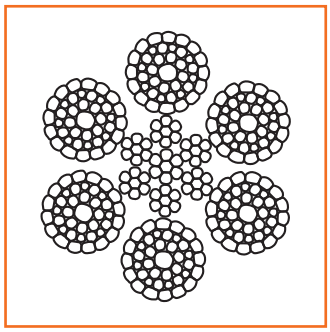


Nominal Rope Diameter (mm)	Estimated Mass (kg/m)	Estimated Breaking Force (Tensile Grade)	Outer Wire Diameter (mm)
		1700MPa	
83,0	31,20	4599	3,86
85,0	32,72	4787	3,94
92,0	38,22	5589	4,26
95,0	40,31	5844	4,34
111,0	54,20	8167	5,030
127,0 *	71,40	9882	5,78

* 1600 MPa Tensile Grade

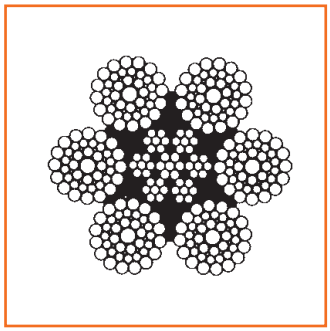
Open Pit Mining Rope Tables

6x41C(16/8+8/8/1)/IWRC



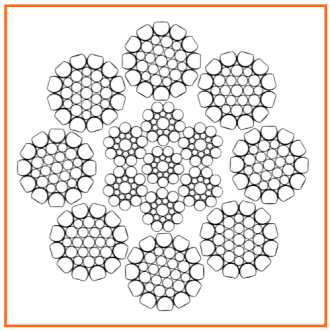
Nominal Rope Diameter (mm)	Estimated Mass (kg/m)	Estimated Breaking Force (Tensile Grade)	Outer Wire Diameter (mm)
		1600MPa	
38,0	6,88	1007	2,00
44,0	9,41	1360	2,20
48,0	11,22	1620	2,53
50,0	11,78	1743	2,60
56,0	14,95	2063	2,80

6x49C(16/8+8/8/8/1)/IWRC



Nominal Rope Diameter (mm)	Estimated Mass (kg/m)	Estimated Breaking Force (Tensile Grade)	Outer Wire Diameter (mm)
		1600MPa	
60,0	16,81	2413	3,10
64,0	19,05	2738	3,30
67,0	20,90	3005	3,45
70,0	22,70	3267	3,60

Shovel Ropes



Nominal Rope Diameter (mm)	Minimum Breaking Force (kN)	Mass (kg/m)	Construction
35	813	5,81	8 x 37 Plasticated Compact Strand
38	956	6,78	8 x 37 Plasticated Compact Strand
44	1289	9,11	8 x 37 Plasticated Compact Strand
50	1679	11,86	8 x 37 Plasticated Compact Strand
56	2114	14,91	8 x 37 Plasticated Compact Strand
60	2430	17,14	8 x 37 Plasticated Compact Strand
64	2743	19,33	8 x 37 Plasticated Compact Strand
67	2978	20,98	8 x 37 Plasticated Compact Strand
70	3288	23,14	8 x 37 Plasticated Compact Strand
73	3331	23,74	8 x 37 Plasticated Compact Strand
73	3326	23,88	8 x 37 Plasticated Compact Strand

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