

YOUR ROPE IS
OUR PASSION



HIGH PERFORMANCE ROPES
UNDERGROUND MINING



CASAR[®]

A WireCo[®] WorldGroup Brand

INTRODUCTION



Quality Products, Outstanding Service and Comprehensive Technical Support – It's what today's industries expect from their supplier partners. And that's what WireCo WorldGroup is all about.

WireCo WorldGroup is the global market, manufacturing and technical leader in wire and synthetic rope manufacturing, providing a consultative approach to offer customers a single, reliable source for performance matched solutions to fit their specific application and budget needs. But it doesn't stop there.



Deeper shafts. Higher payloads. Faster speeds. Underground mining becomes more demanding every day. To efficiently hoist materials and personnel from underground, we have developed specialized underground ropes to meet this challenging but also permanently changing environment.

WireCo WorldGroup is a world leader in wire and synthetic rope manufacturing. From hoisting to hauling, you can rely on our ropes to reliably meet the demands of your operation. Drawing on more than 70 years of global mining experience, we've developed specialized products that overcome obstacles and improve service life. Combined with our unmatched field expertise and consultative approach, it's everything you need to maximize performance and value for your mining application.

The impressive strengths of the high-performance ropes from Casar are particularly evident when it comes to underground mining. For many decades, Casar engineers have been working closely with the mines as well as state and private institutes to improve the performance of the types of ropes used underground.

WireCo WorldGroup offers clients the education and expertise needed to enhance product performance and value.

With our comprehensive range of trusted, global brands we deliver unmatched technical expertise and innovation as well as unparalleled quality assurance meeting and exceeding international quality certifications.

WireCo WorldGroup is on the ground everywhere you are – with manufacturing and distribution facilities all around the world and about 4.000 global employees supporting these efforts. Our customers enjoy global availability for a consistent, responsive supply no matter where and when they need it.

SO WHY SELECT CASAR ROPES?

CASAR stands for highest technical demand. All wire ropes are developed by the use of special computer technology and approved at one of the various test facilities. CASAR Special Wire Ropes are known all over the world because of their high breaking loads, their excellent rotation resistance and their particularly long service time.

In order to keep its leading position in the market, CASAR invests permanently in new technologies to improve its products and testing facilities. Quality is self-evident at CASAR. For many years the company has been certified by the ISO EN 9001 and approved by many classification societies.



THE MOST COMPREHENSIVE RANGE OF PRODUCTS.

Through our Casar brand, we are committed to providing the broadest range of special steel wire ropes for all of your mining applications. Our comprehensive line of underground mining ropes for drum hoists, friction winders, shaft sinking and many other applications offer strength and reliability while ensuring convenient sourcing for all your needs, including specialty applications.

Innovative hoisting products from CASAR deliver precisely engineered and custom designed solutions for all challenging mining applications.



- Proprietary German-engineered designs deliver record setting service life
- Lower torque designs and innovative wire arrangements require less maintenance and resist drum crushing — lowering cost of ownership and improving mine profitability
- Decades of global mining experience and on-site engineering support help enhance safety and further improve rope performance
- Wide range of different product solutions to fit application requirements
- Global mining and manufacturing experience ensures reliable product performance

SUPERIOR QUALITY IN ALL WE DO.

From raw materials to training and testing, at WireCo WorldGroup we take quality as seriously as you do. With an ISO 9001 registered quality system for all plants producing mining products, you can have assurance in every product you order. Also, we produce ropes in accordance with many different national and international quality and safety standards. All of our manufacturing sites utilize the same corporate quality system, ensuring that the same quality processes are followed regardless of manufacturing location. By committing to quality in every product, we are able to provide consistently high performance that delivers greater value. For a complete list of our quality certifications, visit www.casar.de or www.wireco.com.



SERVICE THAT ADDS VALUE.

Our representatives are there for more than taking orders. They are available to help you with product selection as well as proper installation, use and maintenance. Backed by an experienced engineering team, they can facilitate custom designs and provide training and information to further enhance performance and value.

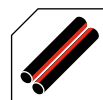
Expertise. Experience. Exceptional products. That's the WireCo advantage — helping customers find and apply the right solutions to minimize cost and maximize value.

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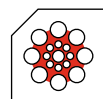
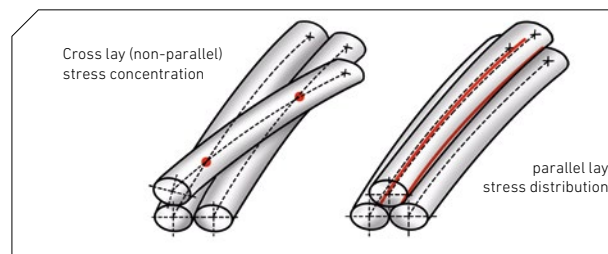
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GENERAL DEFINITIONS



PARALLEL LAY ROPES

In a standard rope all wires and strands have different lay lengths. The high stress concentration at the crossover point leads to an early internal failure. In a parallel lay rope all wires and strands have the same lay length. The linear contact leads to an optimal stress distribution. Furthermore the compacted parallel design leads to a higher fill factor and breaking strength.

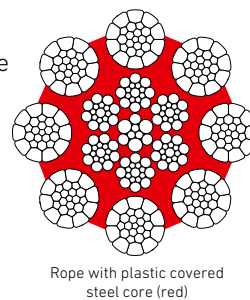


ROPES WITH PLASTIC COVERED STEEL CORE (SINCE 1972)

In a CASAR **PLAST** rope, the proportion of plastic to the steel components is thoroughly harmonized in order to fulfill the aspired rope geometry. A plastic coating with a very constant thickness and quality is extruded around the steel core. A thermal aftertreatment just before the closing of the rope ensures that the outer strands are deeply implanted in the plastic jacket, thus forming plastic edges which separate the strands.

The benefit of an internal plastic layer is diversified:

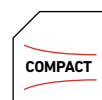
- Prevents internal wire breaks
- Prevents metal-to-metal contact
- Stabilizes the rope structure during installation and operation
- Seals in lubricant, reduces the maintenance effort
- Keeps out water and abrasive elements
- Absorbs dynamic energy
- Resistant to many chemical substances



SWAGED ROPES (SINCE 2003)

Swaged ropes are designed for heavy duty applications such as multiple layer spooling.

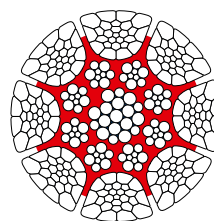
- Extremely high pressure resistance
- Reduced diameter reduction under tension
- Strongly improved crushing resistance in crossovers
- Extremely smooth surface for less indentations or pressure
- High breaking load



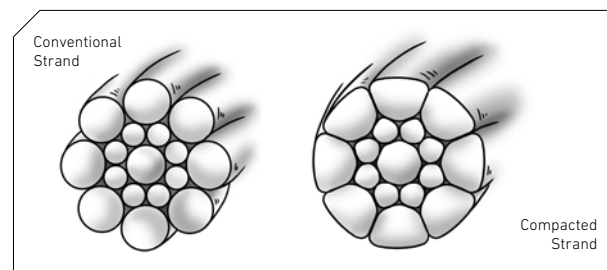
ROPES WITH COMPACTED STRANDS (SINCE 1978)

Ropes made of compacted strands have a higher breaking load, a greater flexibility and better rope-to-rope contact conditions than comparable ropes made out of conventional strands. Because of the thicker outer wires and the smaller exposed area they are more resistant to abrasion and corrosion. The formation of negative impressions is significantly impaired. The rope life time on multiple layer drums is optimized.

In order to produce a compacted strand, a conventional strand made of round wires is drawn through a compacting tool. During this procedure, the wires are plastically deformed, the strand diameter is reduced and the surface is made smooth. The result being that the contact conditions between the individual wires and the strand-to-strand contacts are improved.

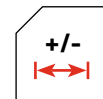


Swaged rope for heavy duty applications



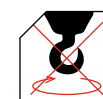
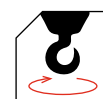
LUBRICATED

As a standard feature, CASAR special wire ropes receive intensive lubrication during the production process. This in-process treatment will provide the rope with ample protection against corrosion and is meant to reduce the friction between the elements which make up the rope as well as the friction between rope and sheaves or drums. This lubrication, however, only lasts for a limited time and should be reapplied periodically.



PRODUCTION TOLERANCE

CASAR special wire ropes are produced within a tolerance range between +0% and +4%. Generally the standard production tolerance is at the upper limit of the tolerance range, between +2% and +4%. For this reason CASAR special wire ropes fulfill the requirements of famous drum manufacturers. Of course, special tolerances or limited tolerance ranges can also be covered.

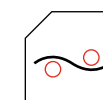


SWIVEL USE

Rotation resistant ropes can be used with a swivel. All other rope constructions may not be used with a swivel!

ISO 21669 – General guidance on swivel use (rotation resistance)

- Less than or equal to 1 turn/1000d lifting a load equivalent to 20%MBF, a swivel can be used
- Greater than 1 turn but no greater than 4 turns/1000d – a swivel may be used subject to the recommendations of the rope manufacturer and/or approval of a competent person
- Greater than 4 turns/1000d – a swivel should not be used

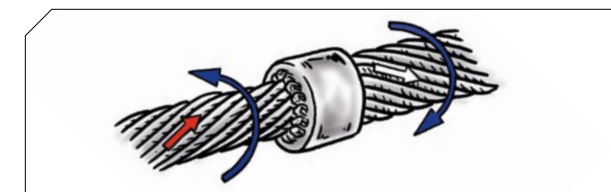


PREFORMED ROPES

In particular the non-rotating ropes are preformed for better dimensional stability during production.

ROTATION-RESISTANT ROPES SINCE 1949

In a conventional rope, an external load creates a torsional moment which tries to un-twist the rope. A rotation resistant steel wire rope has a steel core which is an independent rope, closed in the opposite direction to the outer strands. Under load, the core tries to twist the rope in one direction, the outer strands try to twist it in the opposite direction. The geometrical design of a rotation resistant wire rope is such that the torsional moments in the core and the outer strands compensate each other over a wide load spectrum, so that even with great lifting heights practically no rope twist occurs.



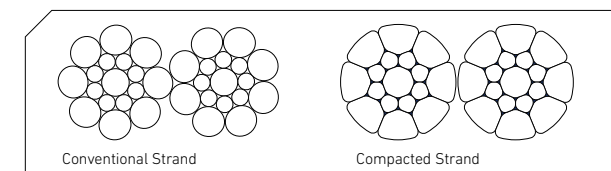
MULTIPLE LAYER SPOOLING

A drum coiling a rope in more than one layer is a multiple layer system with new demands to a wire rope.

- Low diameter reduction under tension
- Crushing resistance in crossovers and layer crossovers
- Extremely smooth surface for less indentations or pressure in crossovers

The following rope properties are required for a long service life:

- Lang's lay to prevent indentations
- Compacted outer strands to prevent indentations

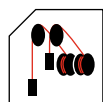


DRUM WINDER

Mine hoist that winds a rope on and off a winder drum. There are single drum arrangements, today mainly operated for emergency or auxiliary hoisting, winding a single rope to hoist a guided or unguided conveyance. Beside the single drum winders, there are double drum winder machines hoisting two conveyances each with one or two hoist ropes. The latter is referred to as a BMR or BLAIR winder (named after its inventor Robert Blair).

In most applications, the hoist rope is multi-layered on the drum. At a single rope layer drum, the rope travels around smooth, curved surfaces of the same geometry. At a multi-layer winding drum, the rope sections spooling in the first layer will also travel around a smooth drum surface, but when the second layer comes in they will be spooled over, compressed and damaged on the upper side by the second rope layer. Rope sections spooling in the second and higher layers will be damaged on all sides. Then they will travel around a very rough surface created by the previous rope layer, leading to wire damage.

CASAR offers the very popular round and triangular six strand standard rope designs that have been used with excellent success. The continuously increasing mine hoist performances as well as economic demands are developing the demands for a suitable hoist rope technology. The CASAR high performance special mining ropes, such as the CASAR Turboplast M, are able to fulfill all kinds of these demands and are able to achieve service life performances that surpass all others.



Rope designs generally suitable for drum winder applications are identified with this symbol.

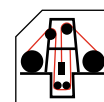
It is fundamental part of CASAR's philosophy to offer its customers not only the highest quality at all times, but also a full technical support, which begins even before a purchase. In order to find the best solution, the correct selection of the product and its characteristics, the following drum winder datasheets are used, please see pages C12/C13.

SHAFT SINKING

The core component of an underground mining operation is the vertical shaft, either to serve the production, the service and support or the ventilation of the mine. The shaft sinking is another special type of the multi-layer drum winder application.

At a single rope layer drum, the rope travels around smooth, curved surfaces of the same geometry. At a multi-layer winding drum, the rope sections spooling in the first layer will also travel around a smooth drum surface, but when the second layer comes in they will be spooled over, compressed and damaged on the upper side by the second rope layer. Rope sections spooling in the second and higher layers will be damaged on all sides. Then they will travel around a very rough surface created by the previous rope layer, leading to wire damage.

The shaft sinking is one of the most challenging and high-risk operations in underground mining. With this understanding, CASAR offers a comprehensive range of products and expertise to this discipline. The CASAR rope technology including category 1 rotation resistant hoist ropes developed for small drum to rope diameter ratios as well as multiple fall reevings, supply high performance, economic and particularly safe rope solutions to the industry.



Rope designs generally suitable for shaft sinking applications are identified with this symbol.

It is a fundamental part of CASAR's philosophy to offer its customers not only the highest quality at all times, but also a full technical support, which begins even before a purchase. In order to find the best solution, the correct selection of the product and its characteristics, the following drum winder datasheet are used, please see pages C12/C13.

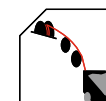
SLOPE HOISTS

A special type of the drum winder application is the slope mine hoist. Where the drum winder application is hoisting in a vertical mine shaft, the slope mining accesses the mine primarily on an incline. The slope drum winds and unwinds a rope, usually on a single drum, but also on double drum winder machines.

There are single layer and multi-layer slope drum winders. At a single rope layer drum, the rope travels around smooth, curved surfaces of the same geometry. At a multi-layer winding drum, the rope sections spooling in the first layer will also travel around a smooth drum surface, but when the second layer comes in they will be spooled over, compressed and damaged on the upper side by the second rope layer. Rope sections spooling in the second and higher layers will be damaged on all sides. Then they will travel around a very rough surface created by the previous rope layer, leading to wire damage.

At a slope mine hoist, the conveyance is moved on a rail system (or kind of). Rollers arranged in equal distances from each other along the route lead the rope and prevent contact with the ground and slack rope. The application therefore makes great demands to a hoist rope, such as a high resistance to abrasion and external damage.

CASAR offers the very popular round and triangular six strand standard rope designs that have been used with excellent success. The continuously increasing mine hoist performances as well as economic demands are developing the demands for a suitable hoist rope technology. The CASAR high performance special mining ropes, such as the CASAR Duroplast M, are able to fulfill all kinds of these demands and are able to achieve service life performances that surpass all others.



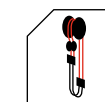
Rope designs generally suitable for slope winder applications are identified with this symbol.

It is a fundamental part of CASAR's philosophy to offer its customers not only the highest quality at all times, but also full technical support, which begins even before a purchase. In order to find the best solution, the correct selection of the product and its characteristics, the following drum winder datasheets are used, please see pages C12/C13.

KOEPE FRICTION WINDER

Beside the drum winder applications, the most common mine hoist system of the eastern hemisphere countries is the friction winder mine hoist. One advantage of the friction hoists, also known as Koepe winders (named after its inventor Carl Friedrich Koepe), is a larger lift capacity by using several hoisting ropes. The Koepe winders are either floor-mounted at the bank level or at the top of a headframe as a shaft-head-mounted machine. In difference to drum winders, the hoist ropes are not connected to the drum, but to both conveyances. The hoisting operation is the result of the transfer of friction between the rope grooves of the Koepe drum (also referred to "traction sheave") and the ropes outer surface. Tail ropes are connected to the bottom side of the conveyances and balance the loads (therefore referred to as balance ropes). With head and tail ropes, the system is in balance and the winder needs to hoist the payload only, which is another advantage of Koepe winder machines.

CASAR offers the very popular round and triangular six strand standard rope designs that have been used with excellent success. The continuously increasing mine hoist performances as well as economic demands are developing the demands for a suitable hoist rope technology. The CASAR high performance special mining ropes, such as the CASAR Turboplast M, are able to fulfill all kinds of these demands and are able to achieve service life performances that surpass all others. At greater winding distances of more than 800m approx., a rotation resistant rope design is to be used, such as the CASAR Starplast VM.



Rope designs generally suitable for Koepe winder applications are identified with this symbol.

It is a fundamental part of CASAR's philosophy to offer its customers not only the highest quality at all times, but also full technical support, which begins even before a purchase. In order to find the best solution, the correct selection of the product and its characteristics, the following Koepe winder datasheet are used, please see pages C14/C15.

UNDERSTANDING YOUR PROJECT

When customers come to CASAR they may be just looking for a rope, but in fact, they are looking for our expertise and hands-on approach to understand and resolve the issues they encounter in the field or their project. Particularly in the mining industry each project is quite unique and needs a dedicated approach in order to find the best solution. Innovative hoisting products from CASAR deliver precisely engineered and custom designed solutions for all challenging mining applications.

Your rope is our passion and we are there to create value and solve problems. This is a task that must be done in teamwork between the mine and CASAR. Our people are an extension of your team to overcome challenges and create solutions for you. Together, we can succeed with a well-established, cost-efficient product selection or we

will work out a high performance, customized product solution to maximize the value for money for your service.

Let's start working and challenge our engineers with your project details. As with many activities, a good start is crucial and hence our success begins with a comprehensive collection of the application details. We like to use the following data sheets and sketch to gather the information for a perfect rope selection. Please feel free to fill in as much detail as available or get in contact with us and we will be pleased to go through the specification together.

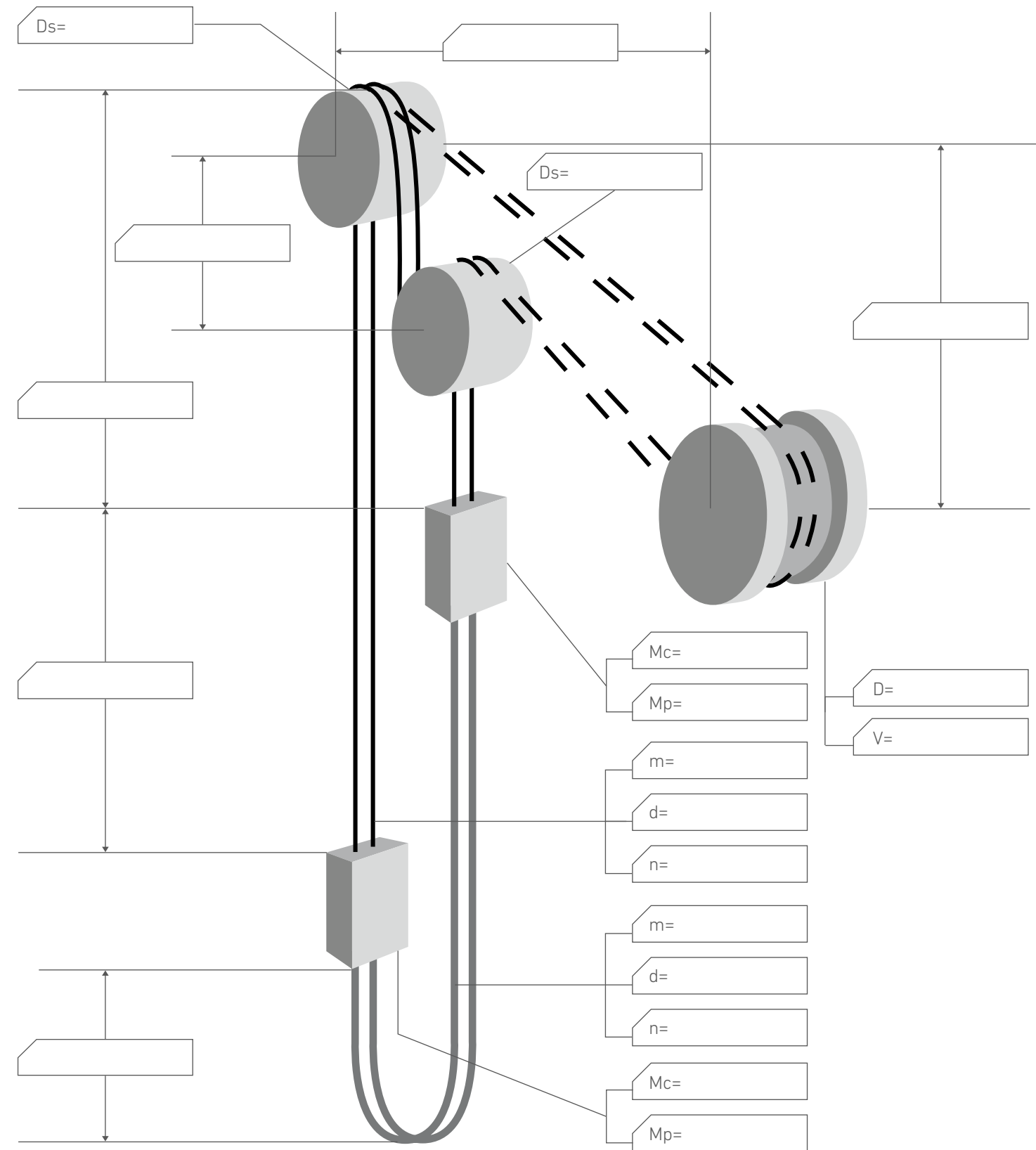
Data confidentiality is granted and is just used just to find the best high performance rope solution for you.

GENERAL INFORMATION

mineral
date
pH value
ventilation direction
temperature range
chloride content
applicable standards

LEGEND

- Ds = sheave diameter
- D = drum diameter
- Mc = mass of conveyance or counterweight incl. attachments
- Mp = mass of payload
- m = rope length mass
- d = rope dimension
- n = number of ropes
- V = hoisting speed



DRUM WINDER QUESTIONNAIRE

I. Company and Contact Details

Company Name	
Contact Person	
Telephone	
Email	
Name of Mine	
Name of Shaft and winder	

II. Winder Specification

Drum Winder Type (Single, Double or Blair Drum Hoist, cylindrical or conical)	
Type of Conveyance Guiding (Rope Guiding, kind and number of ropes) or Rail Guiding (wooden or steel rails)	
Type of Hoisting System (Skip-, or Cage-Counterweight, Skip-Skip, Cage-Cage, Single Conveyance, etc.)	
Type of Usage (Rock-, Material-, Man Hoisting, Auxiliary or Emergency Purpose)	
Diameter of Drum 'D' (mm)	
Compartment Width of Drum (mm)	
Diameter of Headgear Deflection Sheave 'Ds' (mm)	
Type of Drum Coiling Sleeves (e.g. Lebus, Spiral, Flat etc.)	
Last Measured Drum Groove Diameter (mm)	
Last Measured Drum Groove Pitch (mm)	
Last Measured Sheave Groove Diameter (mm)	
Type of Sheave Groove Material / Inserts (e.g. Steel grooves, Becoplast, etc.)	
Maximum Number of Rope Layers on Drum	
Number of Hoist Ropes per Conveyance 'n' (1 or 2)	
Mass of Empty Conveyance and Attachments 'Mc' (kg)	
Mass of Counterweight and Attachments 'Mc' (kg) if applicable	
Payload 'Mp' (kg)	
Hoisting Speed / Maximum Rope Speed 'V' (m/s)	
Acceleration and Deceleration Speed (m/s ²)	
Shaft Environment, Flow of Water, PH-Level, Temperature Range	
Number of Cycles per Week	

II. Hoist Rope Specification

Hoist Rope Nominal Length (i.e. rope service length, after rope installation) (m)	
Hoist Rope Order Length (m)	
Maximum Hoist Rope Suspended Length (m)	
Rope Length from drum to sheave (m)	
Maximum Hoist Rope Winding Length (m)	
Nominal Diameter of Hoist Rope 'd' (mm)	
Current used Hoist Rope Standard and Description of Construction	
Outer Wire Diameter of current used Hoist Rope (mm)	
Hoist Rope Weight per 1m 'm' (kg/m)	
Hoist Rope Aggregate Breaking Load of all Wires (kN)	
Hoist Rope Minimum Breaking Load (kN)	
Hoist Rope Maximum Breaking Load (if applicable) (kN)	
Hoist Rope Tensile Strength of Wires (N/mm ²)	
Hoist Rope Lay Direction	
Hoist Rope Wire Finish (galvanized or ungalvanized)	
Hoist Rope Lubrication	
Type of Hoist Rope Termination to the Conveyance	
Required Hoist Rope Factor of Safety (FoS) with reference to Aggregate Breaking Load	
OR Required Hoist Rope Capacity Factor with reference to Minimum Breaking Load	
Required Hoist Rope Capacity Factor with reference to Aggregate Breaking Load	
OR Required Hoist Rope Capacity Factor with reference to Minimum Breaking Load	
Current Average Hoist Rope Lifetime (cycles)	
Maximum Recorded Hoist Rope Lifetime (cycles)	
Minimum Recorded Hoist Rope Lifetime (cycles)	
Failure Mode of Hoist Ropes	

KOEPE WINDER QUESTIONNAIRE

I. Company and Contact Details

Company Name	
Contact Person	
Telephone	
Email	
Name of Mine	
Name of Shaft and winder	

II. Winder Specification

Koepe Winder Type (Tower or Ground Mounted Koepe Drum)	
Type of Conveyance Guiding (Rope Guiding, kind and number of ropes) or Rail Guiding (wooden or steel rails)	
Type of Hoisting System (Skip-, or Cage-Counterweight, Skip-Skip, Cage-Cage, Single Conveyance, etc.)	
Type of Usage (Rock-, Material-, Man Hoisting, Auxiliary or Emergency Purpose)	
Diameter of Koepe Drum 'D' (mm)	
Angle of Wrap on Koepe Drum (°)	
Diameter of Deflection Sheave if installed 'Ds' (mm)	
Angle of Wrap on Deflection Sheave (°)	
Type of Koepe Drum Groove Insertion (e.g. Becorit K25, Modar etc.)	
Type of Sheave Groove Material / Inserts (e.g. Steel grooves, Becoplast, etc.)	
Last Measured Koepe Drum Groove Diameter(s) (mm)	
Last Measured Sheave Groove Diameter(s) (mm)	
Mass of empty Conveyance and Attachments 'Mc' (kg)	
Mass of Counterweight and Attachments 'Mc' (kg) if applicable	
Payload 'Mp' (kg)	
Hoisting Speed / Maximum Rope Speed 'V' (m/s)	
Acceleration and Deceleration Speed (m/s ²)	
Shaft Environment, Flow of Water, PH-Level, Temperature Range	
Number of Cycles per week	

II. Hoist Rope Specification

Number of Hoist Ropes 'n'	
Hoist Rope Nominal Length (i.e. rope service length, after rope installation) (m)	
Hoist Rope Order Length (m)	
Maximum Hoist Rope Suspended Length (m)	
Rope Length from drum to sheave (m)	
Maximum Hoist Rope Winding Length (m)	
Nominal Diameter of Hoist Rope 'd' (mm)	
Hoist Rope Standard and Description of Construction	
Hoist Rope Weight per 1m 'm' (kg/m)	
Hoist Rope Aggregate Breaking Load of all Wires (kN)	
Hoist Rope Minimum Breaking Load (kN)	
Hoist Rope Maximum Breaking Load (if applicable) (kN)	
Hoist Rope Tensile Strength of Wires (N/mm ²)	
Hoist Rope Lay Direction	
Hoist Rope Wire Finish (galvanized or ungalvanized)	
Hoist Rope Lubrication	
Type of Hoist Rope Termination to the Conveyance	
Certified rope nominal diameters for hoist rope attachments (mm)	
Required Hoist Rope Factor of Safety (FoS) with reference to Aggregate Breaking Load	
OR Required Hoist Rope Capacity Factor with reference to Minimum Breaking Load	
Required Hoist Rope Capacity Factor with reference to Aggregate Breaking Load	
OR Required Hoist Rope Capacity Factor with reference to Minimum Breaking Load	
Failure Mode of Hoist Ropes	
Current Average Hoist Rope Lifetime (cycles)	
Maximum Recorded Hoist Rope Lifetime (cycles)	
Minimum Recorded Hoist Rope Lifetime (cycles)	

ROPE LIFE RECORD IN A SOUTH AFRICAN PLATINUM MINE

The service life of wire rope in Mine Winding is critically important, not only due to the high cost of materials, but more importantly the down time in production during a failure or changeover. Ropes from Casar have already saved Millions of Dollars for Mining Operations all around the world.

Casar has been a leader in the development and production of high-performance ropes for underground mining since its foundation in 1948. The clearly defined task has always been to increase the service life of the ropes used in order to be able to extend the replacement intervals and hence save money for the mine. At the same time, the CASAR engineers are pursuing the goal of placing the safety reserves in an area that is optimal for mining operations until they are ready for discard. Larger intervals for changing the rope must never be at the expense of operational safety!

A milestone in this challenging task was the introduction of the plastic-coated rope core. Here Casar has taken a unique approach in which a closed plastic layer is extruded in a special work step. This protects the rope core from penetrating dirt and moisture and seals the important lubricant for the entire life of the rope. But an additional effect that the plastic has is just as important. By

avoiding steel / steel contact between the outer strands, friction and thus wear are greatly reduced. Special plastic materials and lubricants optimize these special Casar rope constructions.

In this South African platinum mine, too, the aim was to extend the service life and thus the rope replacement intervals. Traditionally, triangular strand ropes were used in this mine, which averaged a service life of 16.7 months and 116,800 cycles. The Casar experts suggested a Turboplast M, a compacted eight-strand rope with a plastic-coated heart. This proven construction is characterized by good wear resistance, pressure stability and a long service life. Casar countered the higher price of the rope with a performance guarantee of 36 months. The reality has far exceeded this assumption. The rope was discarded after 57 months and 402,000 cycles. That is almost 3.5 times the original rope life!

Turboplast M Lifetime:

57 Months

Turboplast M Cycles:

402,000 Cycles

3.4 TIMES LONGER SERVICE LIFE

COST SAVING TOTAL: 50% LESS FOR TURBOPLAST M

Original Lifetime:

16.7 Months

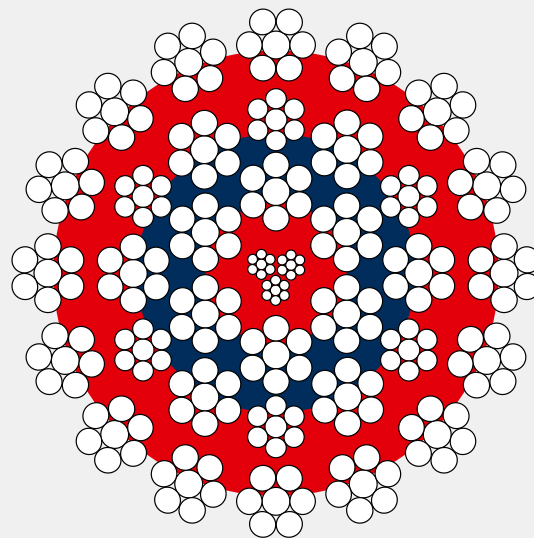
Original Cycles:

116,800 Cycles

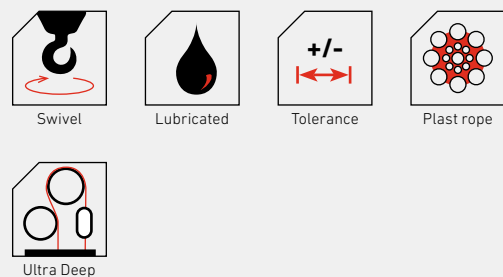


CASAR STARPLAST M

- High performance mining rope
- Category 1 rotation resistant
- Fully lubricated
- Plastic layer between steel core and outer strands
- High breaking force
- Available in ordinary (regular) lay or lang's lay



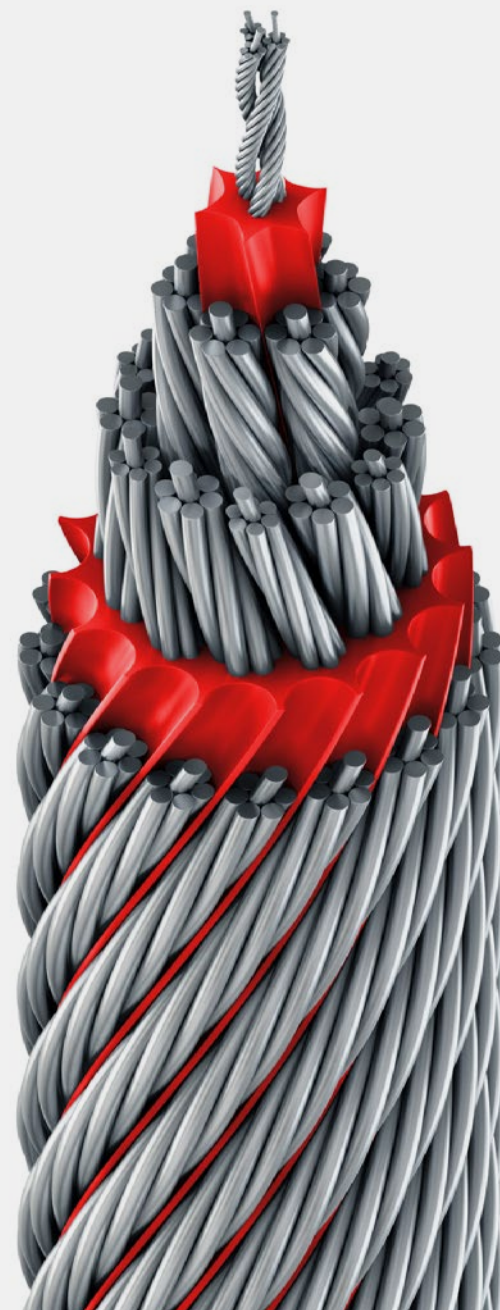
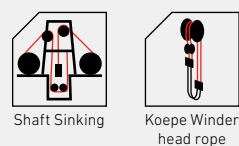
PROPERTIES



APPLICATIONS

High performance hoist rope for drum and particularly for koepe friction winder applications, where rotation-resistant ropes are required. Rope design and manufacturing parameters are adjusted according to the application, i.e. Starplast MD and Starplast MF. The Starplast M with conventional strands offers a very high fatigue resistance. This design is continuously improved, particularly the inner elements, to achieve the optimum strand-to-strand contact conditions and to offer the best possible service life.

Less recommended for multi-layer drum winder applications.

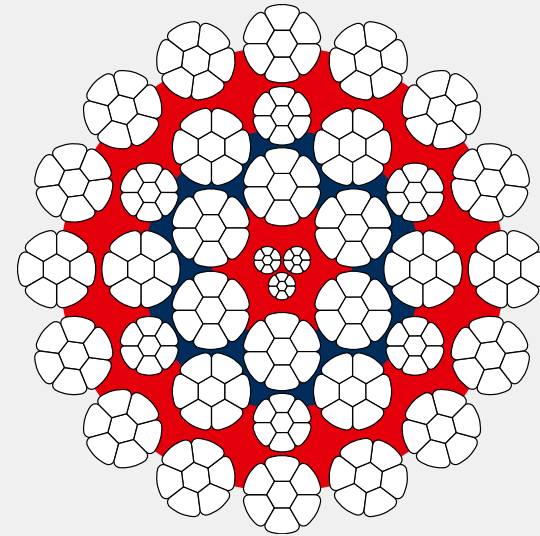


Nominal Diameter		metallic area		Weight		Aggregate Breaking Force				Minimum Breaking Force			
						1770 N/mm ²		1960 N/mm ²		1770 N/mm ²		1960 N/mm ²	
mm	inch	mm ²	Sqin	kg/m	lb/ft	kN	lbs	kN	lbs	kN	lbs	kN	lbs
20		198.3	0.3074	1.77	1.19	351.0	78,917	388.7	87,389	287.9	64,712	318.8	71,659
21		218.7	0.3389	1.95	1.31	387.0	87,006	428.6	96,346	317.4	71,345	351.4	79,004
22		240.0	0.3720	2.14	1.44	424.8	95,490	470.4	105,740	348.3	78,302	385.7	86,707
	7/8	244.9	0.3796	2.19	1.47	433.5	97,453	480.0	107,914	355.5	79,912	393.6	88,490
23		262.3	0.4065	2.34	1.57	464.3	104,368	514.1	115,572	380.7	85,582	421.6	94,769
24		285.6	0.4427	2.55	1.71	505.5	113,641	559.8	125,840	414.5	93,186	459.0	103,189
25		309.9	0.4803	2.77	1.86	548.5	123,308	607.4	136,545	449.8	101,113	498.1	111,967
	1	319.9	0.4958	2.86	1.92	566.2	127,286	627.0	140,949	464.3	104,374	514.1	115,578
26		335.2	0.5195	2.99	2.01	593.3	133,370	656.9	147,687	486.5	109,364	538.7	121,103
27		361.5	0.5603	3.23	2.17	639.8	143,827	708.5	159,266	524.6	117,938	580.9	130,598
28		388.7	0.6025	3.47	2.33	688.0	154,678	761.9	171,282	564.2	126,836	624.8	140,451
	1 1/8	404.9	0.6275	3.62	2.43	716.6	161,096	793.5	178,389	587.6	132,099	650.7	146,279
29		417.0	0.6463	3.73	2.50	738.1	165,924	817.3	183,735	605.2	136,057	670.2	150,662
30		446.2	0.6917	3.99	2.68	789.8	177,564	874.6	196,625	647.7	145,602	717.2	161,232
31		476.5	0.7386	4.26	2.86	843.4	189,599	933.9	209,951	691.6	155,471	765.8	172,160
	1 1/4	499.8	0.7747	4.47	3.00	884.7	198,884	979.6	220,233	725.4	163,085	803.3	180,591
32		507.7	0.7870	4.54	3.05	898.7	202,028	995.1	223,715	736.9	165,663	816.0	183,446
33		540.0	0.8369	4.82	3.24	955.7	214,852	1,058.3	237,916	783.7	176,179	867.8	195,091
34		573.2	0.8884	5.12	3.44	1,014.5	228,071	1,123.4	252,553	831.9	187,018	921.2	207,094
35	1 3/8	604.8	0.9374	5.40	3.63	1,070.5	240,650	1,185.4	266,482	877.8	197,333	972.0	218,515
36		642.6	0.9960	5.74	3.86	1,137.4	255,692	1,259.5	283,139	932.6	209,668	1,032.8	232,174
37		678.8	1.0521	6.06	4.07	1,201.4	270,095	1,330.4	299,088	985.2	221,478	1,090.9	245,252
38		716.0	1.1097	6.40	4.30	1,267.3	284,892	1,403.3	315,473	1,039.2	233,611	1,150.7	258,688
	1 1/2	719.7	1.1156	6.43	4.32	1,273.9	286,393	1,410.7	317,136	1,044.6	234,842	1,156.8	260,051
39		754.1	1.1689	6.74	4.53	1,334.8	300,083	1,478.1	332,295	1,094.6	246,068	1,212.1	272,482
40		793.3	1.2296	7.09	4.76	1,404.2	315,669	1,554.9	349,555	1,151.4	258,849	1,275.0	286,635
41		833.5	1.2919	7.45	5.00	1,475.3	331,650	1,633.6	367,251	1,209.7	271,953	1,339.6	301,146
	1 5/8	844.7	1.3093	7.55	5.07	1,495.1	336,114	1,655.6	372,194	1,226.0	275,613	1,357.6	305,199
42		874.6	1.3557	7.81	5.25	1,548.1	348,025	1,714.3	385,384	1,269.4	285,381	1,405.7	316,015
43		916.8	1.4210	8.19	5.50	1,622.7	364,795	1,796.9	403,954	1,330.6	299,132	1,473.4	331,242
44		959.9	1.4879	8.58	5.76	1,699.0	381,960	1,881.4	422,961	1,393.2	313,207	1,542.8	346,828
	1 3/4	979.6	1.5185	8.75	5.88	1,734.0	389,813	1,920.1	431,657	1,421.9	319,646	1,574.5	353,959
45		1,004.0	1.5563	8.97	6.03	1,777.1	399,519	1,967.9	442,405	1,457.3	327,606	1,613.7	362,772
46		1,049.2	1.6262	9.37	6.30	1,857.0	417,473	2,056.4	462,286	1,522.7	342,328	1,686.2	379,075
	1 7/8	1,124.6	1.7431	10.05	6.75	1,990.5	447,489	2,204.2	495,525	1,632.2	366,941	1,807.4	406,330
47		1,095.3	1.6977	9.79	6.58	1,938.6	435,821	2,146.7	482,604	1,589.7	357,373	1,760.3	395,735
48		1,142.4	1.7707	10.21	6.86	2,022.0	454,564	2,239.1	503,359	1,658.0	372,742	1,836.0	412,754
49		1,190.5	1.8452	10.64	7.15	2,107.1	473,701	2,333.3	524,551	1,727.8	388,435	1,913.3	430,132
50		1,239.6	1.9213	11.07	7.44	2,194.0	493,233	2,429.5	546,179	1,799.1	404,451	1,992.2	447,867
	2	1,279.5	1.9833	11.43	7.68	2,264.8	509,143	2,507.9	563,797	1,857.1	417,497	2,056.5	462,313
51		1,289.6	1.9989	11.52	7.74	2,282.6	513,160	2,527.7	568,245	1,871.8	420,791	2,072.7	465,961
52		1,340.7	2.0781	11.98	8.05	2,373.0	533,481	2,627.8	590,748	1,945.9	437,455	2,154.8	484,413
53		1,392.8	2.1588	12.44	8.36	2,465.2	554,197	2,729.8	613,687	2,021.5	454,442	2,238.4	503,223
54	2 1/8	1,444.5	2.2389	12.90	8.67	2,556.7	574,775	2,831.2	636,474	2,096.5	471,315	2,321.6	521,909
55		1,499.9	2.3248	13.40	9.00	2,654.8	596,812	2,939.7	660,877	2,176.9	489,386	2,410.6	541,919
56		1,554.9	2.4101	13.89	9.33	2,752.2	618,712	3,047.6	685,127	2,256.8	507,344	2,499.0	561,804
57		1,610.9	2.4969	14.39	9.67	2,851.3	641,006	3,157.4	709,815	2,338.1	525,625	2,589.1	582,048
	2 1/4	1,619.4	2.5101	14.47	9.72	2,866.4	644,384	3,174.1	713,555	2,350.4	528,395	2,602.7	585,115
58		1,667.9	2.5853	14.90	10.01	2,952.3	663,695	3,269.2	734,939	2,420.9	544,230	2,680.7	602,650
59		1,726.0	2.6752	15.42	10.36	3,054.9	686,778	3,382.9	760,500	2,505.1	563,158	2,774.0	623,610
60		1,785.0	2.7667	15.95	10.72	3,159.4	710,256	3,498.5	786,498	2,590.7	582,410	2,868.8	644,929
	2 3/8	1,804.3	2.7967	16.12	10.83	3,193.7	717,971	3,536.5	795,042	2,618.8	588,736	2,899.9	651,934
61		1,845.0	2.8597	16.48	11.08	3,265.6	734,129	3,616.1	812,933	2,677.8	601,985	2,965.2	666,605
62		1,905.9	2.9542	17.03	11.44	3,373.5	758,396	3,735.6	839,805	2,766.3	621,884	3,063.2	688,640
63		1,967.9	3.0503	17.58	11.81	3,483.2	783,057	3,857.1	867,114	2,856.2	642,107	3,162.8	711,034
	2 1/2	1,999.3	3.0989	17.86	12.00	3,538.7	795,536	3,918.6	880,933	2,901.8	652,340	3,213.2	722,365
64		2,030.9	3.1479	18.14	12.19	3,594.7	808,114	3,980.5	894,860	2,947.6	662,653	3,264.0	733,785
65		2,094.8	3.2470	18.72	12.58	3,707.9	833,564	4,105.9	923,043	3,040.5	683,523	3,366.8	756,895

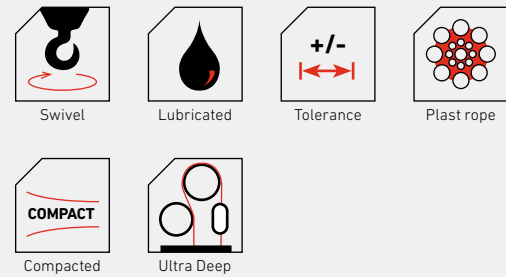
Product specifications are subject to change without notice or obligation. The shown drawings or cross sections are only for illustrative purposes; the images can vary depending on requested diameter and current status of technical development. This table is for reference only. Additional sizes available upon request.

CASAR STARPLAST VM

- High performance mining rope
- Category 1 rotation resistant
- Fully lubricated
- Plastic layer between steel core and outer strands
- Very high breaking force
- Good resistance to drum crushing
- Available in ordinary (regular) lay or lang's lay



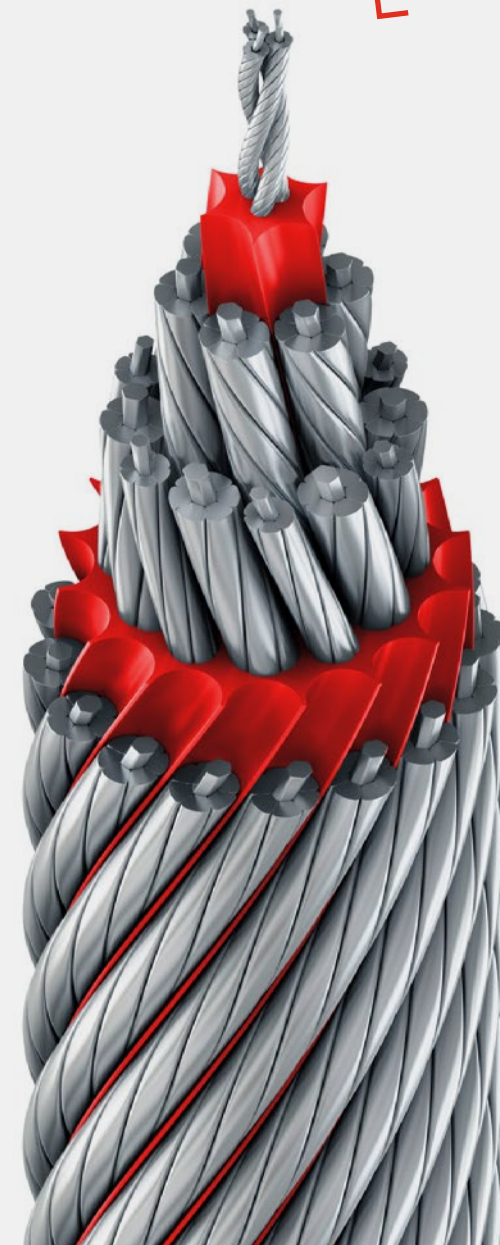
PROPERTIES



IMPROVED DESIGN

APPLICATIONS

High performance hoist rope for drum and for koepe friction winder applications, where rotation-resistant ropes are required. Rope design and manufacturing parameters are adjusted according to the application, i.e. Starplast VMD and Starplast VMF. The Starplast VM with compacted strands offers a very high fatigue resistance as well as a good resistance to drum crushing. This design is continuously improved, particularly the inner elements, to achieve the optimum strand-to-strand contact conditions and to offer the best possible service life.

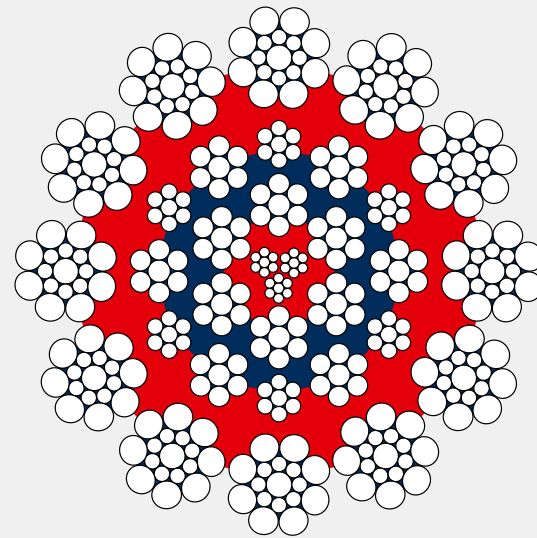


Nominal Diameter		metallic area		Weight		Aggregate Breaking Force				Minimum Breaking Force			
						1770 N/mm ²		1960 N/mm ²		1770 N/mm ²		1960 N/mm ²	
mm	inch	mm ²	Sqin	kg/m	lb/ft	kN	lbs	kN	lbs	kN	lbs	kN	lbs
20		216.3	0.3352	1.89	1.27	382.8	86,055	423.9	95,293	307.6	69,151	340.6	76,570
21		238.4	0.3696	2.08	1.40	422.0	94,876	467.3	105,060	339.1	76,233	375.5	84,416
22		261.7	0.4056	2.29	1.54	463.2	104,127	512.9	115,304	372.2	83,674	412.1	92,644
	7/8	267.1	0.4139	2.33	1.57	472.7	106,268	523.4	117,675	379.9	85,394	420.6	94,548
23		286.0	0.4433	2.50	1.68	506.2	113,808	560.6	126,025	406.8	91,452	450.5	101,276
24		311.4	0.4827	2.72	1.83	551.2	123,920	610.4	137,222	442.9	99,568	490.5	110,269
25		337.9	0.5238	2.95	1.98	598.1	134,461	662.3	148,895	480.6	108,043	532.2	119,643
	1	348.8	0.5407	3.05	2.05	617.4	138,799	683.7	153,698	496.1	111,528	549.4	123,503
26		365.5	0.5665	3.19	2.14	646.9	145,433	716.4	161,045	519.8	116,856	575.6	129,400
27		394.1	0.6109	3.44	2.31	697.6	156,836	772.5	173,671	560.6	126,028	620.8	139,561
28		423.9	0.6570	3.70	2.49	750.3	168,668	830.8	186,774	602.9	135,537	667.6	150,082
	1 1/8	441.5	0.6843	3.86	2.59	781.4	175,667	865.3	194,524	627.9	141,161	695.3	156,310
29		454.7	0.7048	3.97	2.67	804.8	180,931	891.2	200,353	646.7	145,384	716.1	160,986
30		486.6	0.7542	4.25	2.86	861.3	193,624	953.7	214,409	692.1	155,590	766.4	172,294
31		519.6	0.8054	4.54	3.05	919.7	206,748	1,018.4	228,941	739.0	166,134	818.3	183,961
	1 1/4	545.0	0.8448	4.76	3.20	964.7	216,873	1,068.3	240,153	775.2	174,270	858.4	192,970
32		553.6	0.8581	4.83	3.25	980.0	220,302	1,085.1	243,950	787.5	177,037	872.0	196,033
33		588.8	0.9126	5.14	3.46	1,042.2	234,285	1,154.0	259,435	837.4	188,255	927.3	208,465
34		625.0	0.9688	5.46	3.67	1,106.3	248,700	1,225.0	275,396	889.0	199,855	984.4	221,302
35	1 3/8	659.5	1.0222	5.76	3.87	1,167.3	262,416	1,292.6	290,585	942.0	211,770	1,043.1	234,498
36		700.7	1.0861	6.12	4.11	1,240.2	278,819	1,373.4	308,749	996.6	224,045	1,103.6	248,099
37		740.2	1.1473	6.46	4.34	1,310.1	294,524	1,450.7	326,140	1,052.8	236,679	1,165.8	262,082
38		780.7	1.2101	6.82	4.58	1,381.9	310,660	1,530.2	344,007	1,110.4	249,628	1,229.6	276,425
	1 1/2	784.8	1.2165	6.85	4.61	1,389.2	312,297	1,538.3	345,820	1,116.3	250,943	1,236.1	277,882
39		822.4	1.2747	7.18	4.83	1,455.6	327,225	1,611.8	362,351	1,169.6	262,936	1,295.2	291,172
40		865.1	1.3409	7.55	5.08	1,531.2	344,221	1,695.5	381,171	1,230.4	276,605	1,362.5	306,302
41		908.9	1.4087	7.94	5.33	1,608.7	361,647	1,781.4	400,468	1,292.7	290,610	1,431.4	321,791
	1 5/8	921.1	1.4277	8.04	5.41	1,630.3	366,515	1,805.3	405,858	1,310.1	294,522	1,450.7	326,123
42		953.7	1.4783	8.33	5.60	1,688.1	379,504	1,869.3	420,241	1,356.5	304,953	1,502.1	337,685
43		999.7	1.5495	8.73	5.87	1,769.5	397,791	1,959.4	440,491	1,421.9	319,656	1,574.5	353,962
44		1,046.7	1.6224	9.14	6.14	1,852.7	416,508	2,051.6	461,217	1,488.8	334,695	1,648.6	370,620
	1 3/4	1,068.3	1.6558	9.33	6.27	1,890.8	425,071	2,093.8	470,700	1,519.4	341,577	1,682.5	378,240
45		1,094.9	1.6970	9.56	6.42	1,937.9	435,655	2,145.9	482,420	1,557.2	350,072	1,724.4	387,660
46		1,144.1	1.7733	9.99	6.71	2,025.0	455,232	2,242.3	504,099	1,627.2	365,809	1,801.9	405,083
	1 7/8	1,226.3	1.9008	10.71	7.20	2,170.6	487,964	2,403.6	540,344	1,744.2	392,111	1,931.5	434,209
47		1,194.3	1.8512	10.43	7.01	2,114.0	475,240	2,340.9	526,255	1,698.7	381,883	1,881.1	422,888
48		1,245.7	1.9308	10.88	7.31	2,204.9	495,678	2,441.6	548,887	1,771.8	398,316	1,962.0	441,075
49		1,298.1	2.0121	11.34	7.62	2,297.7	516,547	2,544.4	571,995	1,846.4	415,087	2,044.6	459,644
50		1,351.7	2.0951	11.80	7.93	2,392.5	537,845	2,649.3	595,580	1,922.5	432,195	2,128.9	478,596
	2	1,395.3	2.1627	12.18	8.19	2,469.6	555,194	2,734.7	614,791	1,984.5	446,136	2,197.6	494,033
51		1,406.3	2.1797	12.28	8.25	2,489.1	559,574	2,756.3	619,642	2,000.2	449,663	2,214.9	497,929
52		1,462.0	2.2660	12.77	8.58	2,587.7	581,734	2,865.5	644,180	2,079.4	467,468	2,302.6	517,645
53		1,518.7	2.3540	13.26	8.91	2,688.2	604,323	2,976.7	669,194	2,160.1	485,610	2,392.0	537,743
54	2 1/8	1,575.1	2.4414	13.76	9.24	2,788.0	626,762	3,087.3	694,042	2,242.4	504,111	2,483.1	558,223
55		1,635.5	2.5351	14.28	9.60	2,894.9	650,793	3,205.6	720,652	2,326.2	522,950	2,575.9	579,085
56		1,695.5	2.6281	14.81	9.95	3,001.1	674,673	3,323.2	747,096	2,411.6	542,149	2,670.4	600,330
57		1,756.6	2.7228	15.34	10.31	3,109.2	698,984	3,443.0	774,016	2,498.5	561,685	2,766.7	621,979
	2 1/4	1,765.9	2.7371	15.42	10.36	3,125.6	702,668	3,461.1	778,095	2,511.7	564,645	2,781.3	625,257
58		1,818.8	2.8192	15.88	10.67	3,219.3	723,725	3,564.9	801,413	2,586.9	581,558	2,864.6	643,988
59		1,882.1	2.9172	16.44	11.04	3,331.3	748,896	3,688.8	829,286	2,676.9	601,791	2,964.2	666,379
60		1,946.4	3.0169	17.00	11.42	3,445.1	774,497	3,815.0	857,636	2,768.4	622,361	3,065.6	689,174
	2 3/8	1,967.5	3.0497	17.18	11.55	3,482.6	782,911	3,856.4	866,952	2,798.5	629,128	3,098.9	696,660
61		2,011.8	3.1183	17.57	11.81	3,560.9	800,529	3,943.2	886,462	2,861.4	643,268	3,168.6	712,329
62		2,078.3	3.2214	18.15	12.20	3,678.6	826,991	4,073.5	915,764	2,956.0	664,535	3,273.4	735,889
63		2,145.9	3.3262	18.74	12.59	3,798.3	853,883	4,206.0	945,543	3,052.2	686,162	3,379.8	759,809
	2 1/2	2,180.1	3.3792	19.04	12.79	3,858.8	867,491	4,273.0	960,611	3,100.8	697,087	3,433.7	771,926
64		2,214.6	3.4326	19.34	13.00	3,919.8	881,206	4,340.6	975,799	3,149.8	708,103	3,488.0	784,133
65		2,284.3	3.5407	19.95	13.41	4,043.3	908,959	4,477.3	1,006,531	3,249.0	730,404	3,597.8	808,817

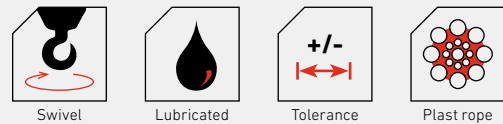
Product specifications are subject to change without notice or obligation. The shown drawings or cross sections are only for illustrative purposes; the images can vary depending on requested diameter and current status of technical development. This table is for reference only. Additional sizes available upon request.

CASAR MINEPLAST M

- High performance mining rope
- Rotation resistant
- Fully lubricated
- Plastic layer between steel core and outer strands
- High breaking force
- Available in ordinary (regular) lay or lang's lay



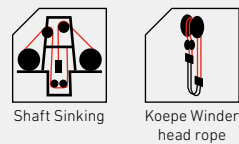
PROPERTIES



APPLICATIONS

High performance hoist rope for drum and particularly for koepe friction winder applications, where rotation-resistant ropes are required. Rope design and manufacturing parameters are adjusted according to the application, i.e. Mineplast MD and Mineplast MF. The Mineplast M with conventional strands offers a very high fatigue resistance. This design is continuously improved, particularly the inner elements, to achieve the optimum strand-to-strand contact conditions and to offer the best possible service life.

Less recommended for multi-layer drum winder applications.

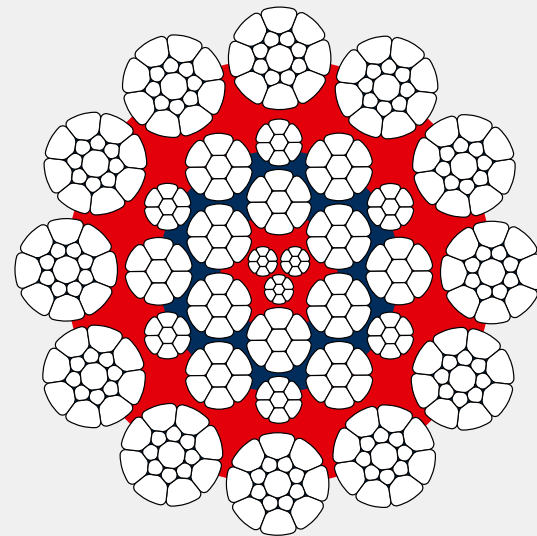


Nominal Diameter		metallic area		Weight		Aggregate Breaking Force				Minimum Breaking Force			
						1770 N/mm ²		1960 N/mm ²		1770 N/mm ²		1960 N/mm ²	
mm	inch	mm ²	Sqin	kg/m	lb/ft	kN	lbs	kN	lbs	kN	lbs	kN	lbs
20		195.6	0.3032	1.75	1.18	346.3	77,842	383.4	86,198	272.6	61,283	301.8	67,847
21		215.7	0.3343	1.93	1.30	381.8	85,821	422.7	95,034	300.5	67,555	332.8	74,816
22		236.7	0.3669	2.12	1.42	419.0	94,189	463.9	104,300	329.8	74,142	365.2	82,100
	7/8	241.6	0.3744	2.16	1.45	427.6	96,126	473.5	106,444	336.6	75,666	372.7	83,788
23		258.7	0.4010	2.32	1.56	457.9	102,946	507.1	113,997	360.5	81,044	399.2	89,744
24		281.7	0.4366	2.52	1.70	498.6	112,093	552.1	124,125	392.5	88,237	434.6	97,702
25		305.7	0.4738	2.74	1.84	541.0	121,629	599.1	134,685	425.9	95,746	471.6	106,020
	1	315.5	0.4891	2.83	1.90	558.5	125,552	618.4	139,029	439.6	98,834	486.8	109,440
26		330.6	0.5124	2.96	1.99	585.2	131,553	648.0	145,675	460.6	103,547	510.1	114,675
27		356.5	0.5526	3.19	2.15	631.1	141,868	698.8	157,096	496.7	111,663	550.1	123,667
28		383.4	0.5943	3.43	2.31	678.7	152,571	751.5	168,949	534.2	120,093	591.6	132,997
	1 1/8	399.3	0.6190	3.58	2.40	706.8	158,901	782.7	175,959	556.4	125,076	616.1	138,515
29		411.3	0.6375	3.68	2.48	728.0	163,663	806.2	181,232	573.1	128,838	634.6	142,664
30		440.2	0.6822	3.94	2.65	779.1	175,145	862.7	193,946	613.3	137,875	679.1	152,668
31		470.0	0.7285	4.21	2.83	831.9	187,016	921.2	207,091	654.8	147,205	725.1	163,009
	1 1/4	493.0	0.7642	4.42	2.97	872.6	196,175	966.3	217,233	686.9	154,414	760.6	170,992
32		500.8	0.7762	4.49	3.01	886.4	199,276	981.6	220,667	697.8	156,872	772.7	173,710
33		532.6	0.8255	4.77	3.21	942.7	211,926	1,043.9	234,675	742.0	166,808	821.7	184,725
34		565.4	0.8763	5.06	3.40	1,000.7	224,964	1,108.1	249,113	787.7	177,082	872.3	196,101
35	1 3/8	596.5	0.9246	5.34	3.59	1,055.9	237,371	1,169.2	262,852	834.7	187,648	924.3	207,791
36		633.8	0.9824	5.68	3.82	1,121.9	252,209	1,242.3	279,282	883.1	198,529	977.9	219,841
37		669.5	1.0378	6.00	4.03	1,185.1	266,415	1,312.3	295,013	932.8	209,702	1,033.0	232,228
38		706.2	1.0946	6.33	4.25	1,250.0	281,011	1,384.2	311,176	983.9	221,189	1,089.6	244,952
	1 1/2	709.9	1.1004	6.36	4.27	1,256.6	282,492	1,391.5	312,816	989.1	222,355	1,095.3	246,243
39		743.9	1.1530	6.66	4.48	1,316.7	295,995	1,458.0	327,769	1,036.4	232,992	1,147.7	258,013
40		782.5	1.2129	7.01	4.71	1,385.0	311,369	1,533.7	344,793	1,090.2	245,087	1,207.3	271,412
41		822.1	1.2743	7.36	4.95	1,455.2	327,132	1,611.4	362,248	1,145.4	257,496	1,268.4	285,148
42		862.7	1.3372	7.73	5.19	1,527.0	343,284	1,690.9	380,134	1,202.0	270,220	1,331.0	299,221
	1 5/8	833.2	1.2914	7.46	5.02	1,474.7	331,535	1,633.0	367,124	1,160.9	260,972	1,285.4	288,980
43		904.3	1.4016	8.10	5.44	1,600.6	359,826	1,772.4	398,451	1,259.9	283,237	1,395.2	313,653
44		946.8	1.4676	8.48	5.70	1,675.9	376,757	1,855.8	417,199	1,319.2	296,568	1,460.8	328,401
	1 3/4	966.3	1.4978	8.66	5.82	1,710.4	384,502	1,893.9	425,777	1,346.3	302,665	1,490.8	335,152
45		990.4	1.5351	8.87	5.96	1,752.9	394,077	1,941.1	436,379	1,379.8	310,191	1,528.0	343,508
46		1,034.9	1.6040	9.27	6.23	1,831.7	411,786	2,028.3	455,989	1,441.8	324,129	1,596.6	358,930
47		1,080.3	1.6745	9.68	6.50	1,912.2	429,884	2,117.5	476,030	1,505.2	338,382	1,666.8	374,711
	1 7/8	1,109.3	1.7194	9.94	6.68	1,963.4	441,393	2,174.2	488,774	1,545.5	347,442	1,711.4	384,743
48		1,126.8	1.7466	10.09	6.78	1,994.5	448,371	2,208.6	496,502	1,569.9	352,927	1,738.5	390,830
49		1,174.3	1.8201	10.52	7.07	2,078.4	467,248	2,301.5	517,405	1,636.0	367,787	1,811.7	407,286
50		1,222.7	1.8951	10.95	7.36	2,164.1	486,514	2,396.4	538,739	1,703.5	382,962	1,886.4	424,080
	2	1,262.1	1.9563	11.31	7.60	2,233.9	502,207	2,473.7	556,116	1,758.4	395,315	1,947.2	437,759
51		1,272.1	1.9717	11.40	7.66	2,251.6	506,169	2,493.2	560,504	1,772.3	398,429	1,962.6	441,210
52		1,322.4	2.0498	11.85	7.96	2,340.7	526,214	2,592.0	582,700	1,842.5	414,210	2,040.3	458,678
53		1,373.8	2.1294	12.31	8.27	2,431.6	546,647	2,692.6	605,327	1,914.1	430,307	2,119.5	476,482
54	2 1/8	1,424.8	2.2084	12.76	8.58	2,521.9	566,945	2,792.6	627,803	1,987.0	446,695	2,200.3	494,647
55		1,479.4	2.2931	13.25	8.91	2,618.6	588,682	2,899.7	651,874	2,061.2	463,376	2,282.5	513,126
56		1,533.7	2.3773	13.74	9.23	2,714.7	610,283	3,006.1	675,794	2,136.9	480,394	2,366.3	531,965
57	2 1/4	1,597.4	2.4759	14.31	9.62	2,827.3	635,606	3,130.8	703,835	2,213.9	497,704	2,451.5	551,119
58		1,645.2	2.5501	14.74	9.90	2,912.0	654,654	3,224.6	724,927	2,292.2	515,307	2,538.3	570,632
59		1,702.4	2.6388	15.25	10.25	3,013.3	677,422	3,336.8	750,140	2,372.0	533,247	2,626.6	590,483
60		1,760.6	2.7290	15.77	10.60	3,116.3	700,580	3,450.9	775,784	2,453.0	551,456	2,716.4	610,671
	2 3/8	1,779.8	2.7586	15.94	10.71	3,150.2	708,191	3,488.3	784,211	2,479.6	557,436	2,745.9	617,303
61		1,819.8	2.8207	16.30	10.95	3,221.1	724,128	3,566.8	801,859	2,535.4	569,980	2,807.7	631,196
62		1,880.0	2.9140	16.84	11.32	3,327.6	748,064	3,684.8	828,365	2,619.3	588,842	2,900.5	652,058
63		1,941.1	3.0087	17.39	11.68	3,435.8	772,390	3,804.6	855,302	2,704.4	607,973	2,994.8	673,258
	2 1/2	1,972.0	3.0567	17.67	11.87	3,490.5	784,699	3,865.2	868,932	2,747.5	617,662	3,042.6	684,004
64		2,003.2	3.1050	17.94	12.06	3,545.7	797,105	3,926.3	882,670	2,791.0	627,442	3,090.7	694,817
65		2,066.3	3.2028	18.51	12.44	3,657.4	822,209	4,050.0	910,469	2,878.9	647,202	3,188.0	716,691

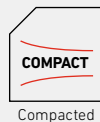
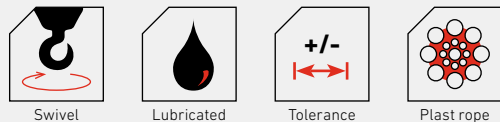
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CASAR MINEPLAST VM

- High performance mining rope
- Rotation resistant
- Fully lubricated
- Plastic layer between steel core and outer strands
- Very high breaking force
- Good resistance to drum crushing
- Available in ordinary (regular) lay or lang's lay

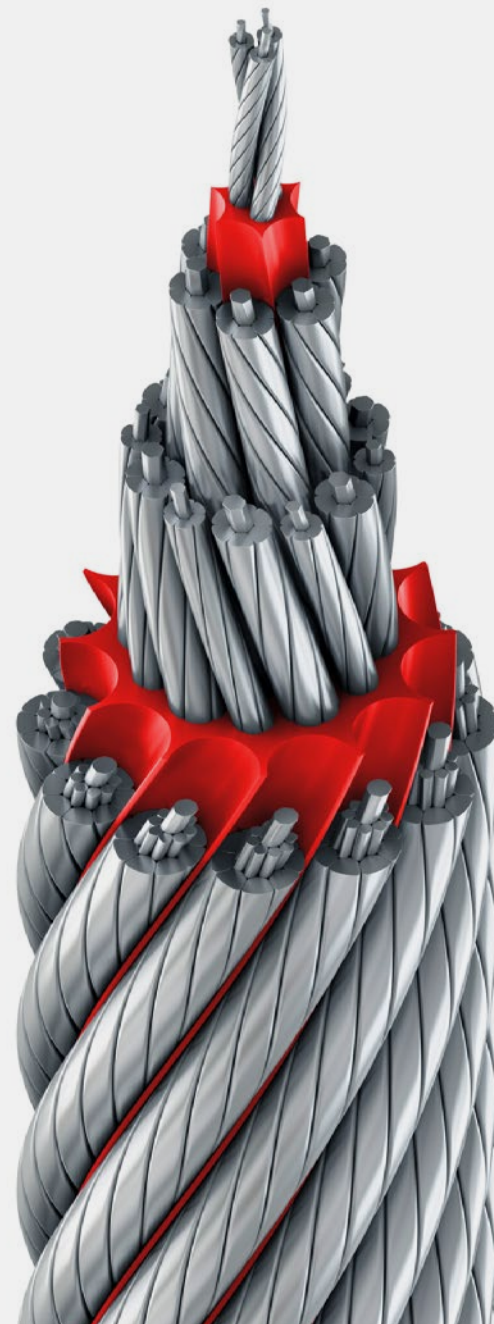


PROPERTIES



APPLICATIONS

High performance hoist rope for drum and for koepe friction winder applications, where rotation-resistant ropes are required. Rope design and manufacturing parameters are adjusted according to the application, i.e. Mineplast VMD and Mineplast VMF. The Mineplast VM with compacted strands offers a very high fatigue resistance as well as a good resistance to drum crushing. This design is continuously improved, particularly the inner elements, to achieve the optimum strand-to-strand contact conditions and to offer the best possible service life.

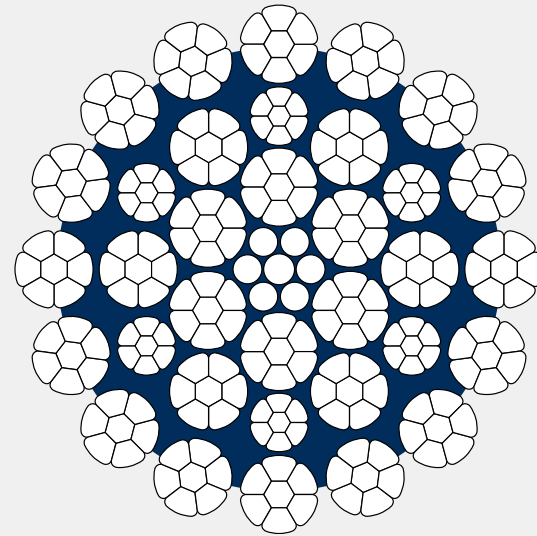


Nominal Diameter	metallic area		Weight		Aggregate Breaking Force				Minimum Breaking Force				
					1770 N/mm ²		1960 N/mm ²		1770 N/mm ²		1960 N/mm ²		
					mm	inch	mm ²	Sqin	kg/m	lb/ft	kN	lbs	kN
20		213.5	0.3309	1.84	1.24	377.9	84,955	418.5	94,075	297.6	66,903	329.6	74,097
21		235.4	0.3648	2.03	1.37	416.6	93,663	461.4	103,717	328.1	73,760	363.4	81,696
22		258.3	0.4004	2.23	1.50	457.3	102,796	506.3	113,830	360.1	80,954	398.8	89,654
	7/8	263.6	0.4087	2.28	1.53	466.7	104,909	516.8	116,171	367.4	82,595	407.2	91,542
23		282.4	0.4377	2.44	1.64	499.8	112,353	553.4	124,414	393.6	88,485	435.9	97,994
24		307.4	0.4765	2.66	1.78	544.2	122,336	602.6	135,468	428.6	96,353	474.6	106,694
25		333.6	0.5171	2.88	1.94	590.5	132,743	653.9	146,992	465.0	104,536	515.0	115,777
	1	344.4	0.5338	2.97	2.00	609.5	137,024	674.9	151,733	480.0	107,908	531.6	119,511
26		360.8	0.5593	3.12	2.09	638.7	143,574	707.2	158,986	503.0	113,079	557.0	125,219
27		389.1	0.6031	3.36	2.26	688.7	154,831	762.7	171,451	542.4	121,936	600.7	135,043
28		418.5	0.6486	3.61	2.43	740.7	166,512	820.2	184,386	583.3	131,131	646.0	145,227
	1 1/8	435.8	0.6755	3.76	2.53	771.4	173,421	854.2	192,037	607.5	136,572	672.8	151,252
29		448.9	0.6958	3.88	2.61	794.5	178,618	879.8	197,792	625.8	140,685	692.9	155,770
30		480.4	0.7446	4.15	2.79	850.3	191,149	941.5	211,668	669.7	150,555	741.5	166,696
31		512.9	0.7951	4.43	2.98	907.9	204,105	1,005.4	226,014	715.0	160,738	791.8	178,004
32	1 1/4	538.1	0.8340	4.65	3.12	952.4	214,100	1,054.6	237,083	761.9	171,282	843.7	189,671
33		581.3	0.9010	5.02	3.37	1,028.8	231,291	1,139.3	256,118	810.3	182,163	897.3	201,721
34		617.0	0.9564	5.33	3.58	1,092.1	245,521	1,209.4	271,876	860.1	193,358	952.5	214,130
35		653.9	1.0135	5.65	3.79	1,157.3	260,175	1,281.5	288,104	911.5	204,913	1,009.3	226,900
36	1 3/8	651.1	1.0091	5.62	3.78	1,152.4	259,061	1,276.1	286,870	964.3	216,783	1,067.8	240,051
37		730.7	1.1326	6.31	4.24	1,293.4	290,759	1,432.2	321,971	1,018.6	228,990	1,128.0	253,584
38	1 1/2	774.8	1.2009	6.69	4.50	1,371.4	308,305	1,518.6	341,399	1,074.4	241,535	1,189.8	267,478
39		811.8	1.2584	7.01	4.71	1,437.0	323,042	1,591.2	357,719	1,131.7	254,416	1,253.2	281,731
40		854.0	1.3237	7.38	4.96	1,511.6	339,821	1,673.9	376,299	1,190.5	267,635	1,318.3	296,366
41		897.2	1.3907	7.75	5.21	1,588.1	357,024	1,758.6	395,349	1,250.8	281,191	1,385.0	311,360
	1 5/8	909.3	1.4094	7.85	5.28	1,609.5	361,830	1,782.3	400,670	1,267.6	284,976	1,403.6	315,551
42		941.5	1.4594	8.13	5.46	1,666.5	374,652	1,845.4	414,869	1,312.5	295,062	1,453.4	326,737
43		986.9	1.5297	8.52	5.73	1,746.8	392,705	1,934.4	434,860	1,375.8	309,292	1,523.5	342,496
44		1,033.4	1.6017	8.93	6.00	1,829.0	411,183	2,025.4	455,322	1,440.5	323,837	1,595.1	358,593
	1 3/4	1,054.6	1.6346	9.11	6.12	1,866.6	419,637	2,067.0	464,683	1,470.1	330,495	1,627.9	365,965
45		1,080.9	1.6753	9.34	6.27	1,913.1	430,086	2,118.5	476,253	1,506.7	338,720	1,668.5	375,094
46		1,129.4	1.7506	9.75	6.55	1,999.1	449,413	2,213.7	497,655	1,574.4	353,939	1,743.5	391,954
47		1,179.1	1.8276	10.18	6.84	2,087.0	469,165	2,311.0	519,527	1,643.6	369,496	1,820.1	409,175
	1 7/8	1,210.6	1.8765	10.46	7.03	2,142.8	481,726	2,372.8	533,437	1,687.6	379,388	1,868.8	420,129
48		1,229.8	1.9062	10.62	7.14	2,176.7	489,342	2,410.4	541,870	1,714.3	385,390	1,898.4	426,777
49		1,281.5	1.9864	11.07	7.44	2,268.3	509,944	2,511.8	564,683	1,786.5	401,621	1,978.3	444,739
50		1,334.4	2.0683	11.53	7.74	2,361.9	530,970	2,615.4	587,967	1,860.2	418,190	2,059.8	463,061
51	2	1,377.4	2.1350	11.90	7.99	2,438.1	548,097	2,699.8	606,932	1,935.3	435,073	2,143.1	481,788
52		1,443.3	2.2371	12.47	8.38	2,554.6	574,297	2,828.8	635,945	2,012.0	452,316	2,227.9	500,852
53		1,499.3	2.3239	12.95	8.70	2,653.8	596,598	2,938.7	660,640	2,090.1	469,873	2,314.4	520,298
54	2 1/8	1,555.0	2.4102	13.43	9.02	2,752.3	618,750	3,047.8	685,170	2,169.7	487,768	2,402.6	540,126
55		1,614.6	2.5027	13.95	9.37	2,857.9	642,474	3,164.6	711,440	2,250.8	506,000	2,492.4	560,314
56		1,673.9	2.5945	14.46	9.71	2,962.7	666,049	3,280.8	737,546	2,333.4	524,569	2,583.9	580,884
57	2 1/4	1,743.3	2.7021	15.06	10.12	3,085.7	693,685	3,416.9	768,149	2,417.5	543,476	2,677.0	601,813
58		1,795.6	2.7831	15.51	10.42	3,178.1	714,473	3,519.3	791,168	2,503.0	562,697	2,771.7	623,103
59		1,858.0	2.8799	16.05	10.78	3,288.7	739,323	3,641.7	818,685	2,590.1	582,278	2,868.1	644,774
60		1,921.5	2.9784	16.60	11.15	3,401.1	764,597	3,766.2	846,672	2,678.6	602,173	2,966.2	666,828
	2 3/8	1,942.4	3.0107	16.78	11.27	3,438.0	772,902	3,807.1	855,869	2,707.6	608,693	2,998.4	674,067
61		1,986.1	3.0785	17.15	11.53	3,515.4	790,296	3,892.8	875,130	2,768.5	622,383	3,065.9	689,242
62		2,051.8	3.1802	17.72	11.91	3,631.6	816,420	4,021.5	904,058	2,860.0	642,953	3,167.2	712,015
63		2,118.5	3.2836	18.30	12.30	3,749.7	842,968	4,152.2	933,456	2,953.0	663,861	3,270.2	735,170
	2 1/2	2,152.2	3.3360	18.59	12.49	3,809.5	856,402	4,218.4	948,332	3,000.1	674,449	3,322.3	746,883
64		2,186.3	3.3887	18.88	12.69	3,869.7	869,941	4,285.1	963,325	3,047.5	685,105	3,374.9	758,708
65		2,255.1	3.4954	19.48	13.09	3,991.6	897,339	4,420.0	993,664	3,143.5	706,687	3,481.2	782,605

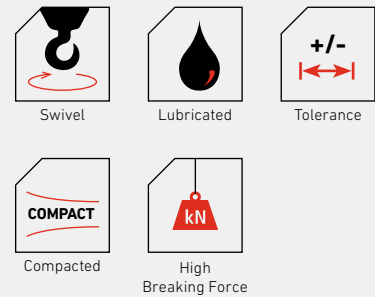
Product specifications are subject to change without notice or obligation. The shown drawings or cross sections are only for illustrative purposes; the images can vary depending on requested diameter and current status of technical development. This table is for reference only. Additional sizes available upon request.

CASAR STARLIFT PLUS M

- High performance mining rope
- Category 1 rotation resistant
- Fully lubricated
- Extremely high breaking force
- Good resistance to drum crushing
- Available in ordinary (regular) lay or langs lay

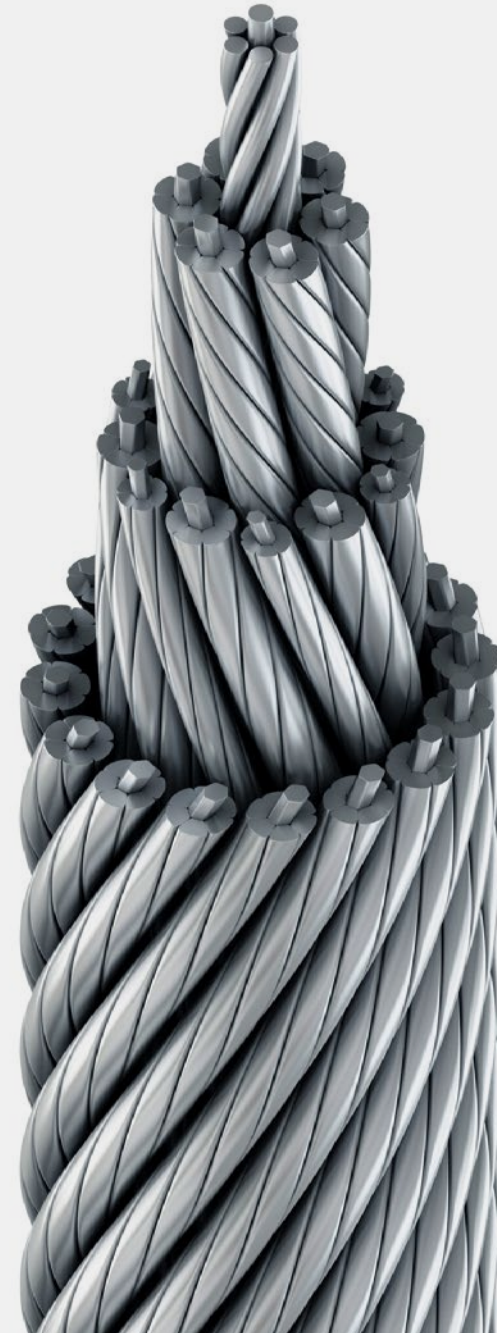


PROPERTIES



APPLICATIONS

High performance hoist rope for drum, koepe friction winder and particularly shaft sinking applications, where rotation-resistant ropes are required. Rope design and manufacturing parameters are adjusted according to the application, i.e. Starlift Plus MD and Starlift Plus MF. The Starlift Plus M with compacted strands offers a very high fatigue resistance as well as a good resistance to drum crushing. It is a very flexible rope with a specially designed core avoiding crossovers between the strands of core and preventing internal rope degradation.

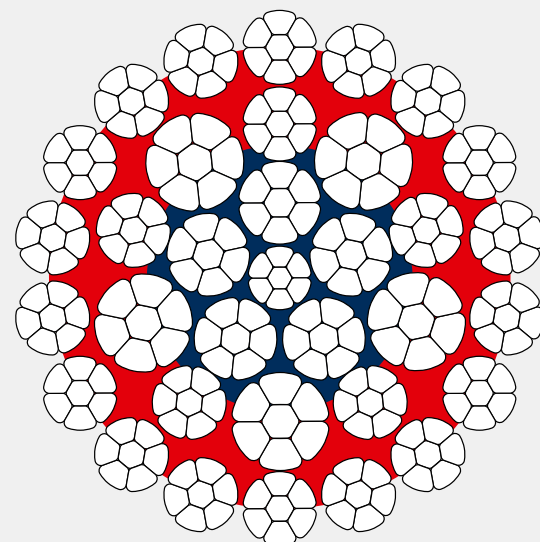


Nominal Diameter	metallic area		Weight		Aggregate Breaking Force				Minimum Breaking Force				
					1770 N/mm ²		1960 N/mm ²		1770 N/mm ²		1960 N/mm ²		
					mm	inch	mm ²	Sqin	kg/m	lb/ft	kN	lbs	kN
20		225.6	0.3497	1.98	1.33	399.3	89,769	442.2	99,405	332.0	74,637	367.0	82,505
21		247.3	0.3833	2.17	1.46	437.7	98,404	484.7	108,967	364.0	81,830	402.0	90,373
22		271.8	0.4213	2.39	1.61	481.1	108,152	532.7	119,762	400.0	89,924	442.0	99,366
	7/8	277.4	0.4300	2.44	1.64	491.0	110,381	543.7	122,229	408.2	91,776	451.1	101,413
23		296.9	0.4602	2.61	1.75	525.5	118,140	581.9	130,822	437.0	98,241	483.0	108,583
24		322.5	0.4999	2.83	1.90	570.8	128,327	632.1	142,102	475.0	106,795	525.0	118,025
25		350.5	0.5433	3.08	2.07	620.4	139,468	687.0	154,439	516.0	116,001	571.0	128,366
	1	361.8	0.5608	3.18	2.14	640.4	143,964	709.1	159,418	532.6	119,741	589.4	132,504
26		377.7	0.5854	3.32	2.23	668.5	150,291	740.3	166,424	556.0	124,994	615.0	138,257
27		410.9	0.6369	3.61	2.43	727.3	163,502	805.4	181,053	605.0	136,009	669.0	150,397
28		441.4	0.6842	3.88	2.61	781.3	175,638	865.1	194,492	650.0	146,126	719.0	161,638
	1 1/8	459.7	0.7125	4.04	2.71	813.7	182,920	901.0	202,556	676.9	152,184	748.8	168,339
29		471.8	0.7313	4.15	2.79	835.1	187,735	924.7	207,887	694.0	156,017	768.0	172,653
30		508.1	0.7876	4.47	3.00	899.3	202,179	995.9	223,882	748.0	168,157	827.0	185,917
31		539.8	0.8367	4.75	3.19	955.4	214,793	1,058.0	237,850	795.0	178,721	879.0	197,607
	1 1/4	566.2	0.8776	4.98	3.35	1,002.2	225,298	1,109.8	249,482	833.9	187,462	922.0	207,271
32		573.4	0.8888	5.04	3.39	1,014.9	228,163	1,123.9	252,655	844.0	189,739	934.0	209,972
33		616.1	0.9550	5.42	3.64	1,090.5	245,153	1,207.6	271,469	907.0	203,902	1,003.0	225,483
34		647.1	1.0030	5.69	3.82	1,145.4	257,489	1,268.3	285,129	953.0	214,243	1,054.0	236,949
	1 3/8	682.8	1.0583	6.00	4.03	1,208.6	271,694	1,338.3	300,859	1,005.6	226,062	1,112.1	250,021
36		729.2	1.1303	6.54	4.39	1,290.7	290,157	1,429.2	321,304	1,074.0	241,441	1,187.0	266,848
38		812.0	1.2586	7.31	4.91	1,437.2	323,104	1,591.5	357,788	1,195.0	268,647	1,322.0	297,197
	1 1/2	816.3	1.2653	7.35	4.94	1,444.9	324,815	1,599.9	359,683	1,201.3	270,069	1,329.0	298,771
40		900.8	1.3962	8.06	5.42	1,594.4	358,439	1,765.6	396,915	1,326.0	298,097	1,467.0	329,795
	1 5/8	959.1	1.4866	8.58	5.77	1,697.6	381,637	1,879.8	422,604	1,411.8	317,389	1,561.9	351,139
42		992.5	1.5384	8.87	5.96	1,756.7	394,927	1,945.3	437,321	1,461.0	328,446	1,616.0	363,291
43		1,040.3	1.6125	9.29	6.24	1,841.3	413,948	2,039.0	458,383	1,531.3	344,250	1,693.8	380,781
44		1,087.1	1.6850	9.77	6.57	1,924.2	432,570	2,130.7	479,004	1,600.0	359,694	1,770.0	397,912
	1 3/4	1,109.4	1.7196	9.97	6.70	1,963.6	441,443	2,174.4	488,830	1,632.8	367,073	1,806.3	406,074
46		1,188.0	1.8414	10.68	7.18	2,102.8	472,719	2,328.5	523,463	1,749.0	393,191	1,935.0	435,005
47		1,240.3	1.9225	11.14	7.49	2,195.3	493,530	2,431.0	546,508	1,756.3	394,824	1,944.8	437,206
	1 7/8	1,273.4	1.9738	11.45	7.69	2,253.9	506,701	2,495.9	561,092	1,803.1	405,361	1,996.7	448,874
48		1,298.8	2.0131	11.58	7.78	2,298.9	516,808	2,545.6	572,284	1,839.1	413,446	2,036.5	457,827
49		1,353.5	2.0979	12.06	8.10	2,395.7	538,574	2,652.9	596,387	1,916.6	430,859	2,122.3	477,109
50		1,410.7	2.1866	12.61	8.47	2,496.9	561,334	2,765.0	621,590	1,997.6	449,067	2,212.0	497,272
	2	1,456.2	2.2571	13.02	8.75	2,577.5	579,439	2,854.2	641,639	2,062.0	463,551	2,283.3	513,311
51		1,467.6	2.2748	13.12	8.82	2,597.7	583,975	2,876.5	646,662	2,078.1	467,180	2,301.2	517,330
52		1,526.3	2.3658	13.61	9.15	2,701.6	607,333	2,991.5	672,527	2,161.2	485,866	2,393.2	538,021
53		1,585.5	2.4575	14.13	9.49	2,806.3	630,889	3,107.6	698,612	2,245.1	504,711	2,486.1	558,889
54	2 1/8	1,654.6	2.5646	14.70	9.88	2,928.6	658,385	3,243.0	729,059	2,342.9	526,708	2,594.4	583,247
55		1,718.1	2.6631	15.26	10.25	3,041.0	683,652	3,367.5	757,039	2,432.8	546,922	2,694.0	605,631
56		1,767.8	2.7401	15.81	10.62	3,129.0	703,428	3,464.9	778,938	2,503.2	562,743	2,771.9	623,150
57	2 1/4	1,831.5	2.8388	16.38	11.01	3,241.8	728,775	3,589.7	807,005	2,593.4	583,020	2,871.8	645,604
58		1,896.3	2.9393	16.96	11.40	3,356.5	754,571	3,716.8	835,570	2,685.2	603,656	2,973.4	668,456
59		1,962.3	3.0415	17.55	11.79	3,473.2	780,814	3,846.1	864,631	2,778.6	624,652	3,076.9	691,705
60		2,029.4	3.1455	18.15	12.20	3,592.0	807,507	3,977.6	894,189	2,873.6	646,006	3,182.0	715,351
	2 3/8	2,051.5	3.1798	18.35	12.33	3,631.2	816,316	4,020.9	903,943	2,904.9	653,053	3,216.8	723,154
61		2,097.7	3.2514	18.76	12.61	3,712.9	834,699	4,111.5	924,300	2,933.2	659,413	3,248.1	730,197
62		2,167.1	3.3590	19.38	13.02	3,835.8	862,315	4,247.5	954,879	3,030.3	681,229	3,355.5	754,355
63		2,237.5	3.4681	20.01	13.45	3,960.4	890,328	4,385.5	985,899	3,128.7	703,359	3,464.5	778,861
	2 1/2	2,273.2	3.5235	20.33	13.66	4,023.6	904,533	4,455.5	1,001,630	3,178.6	714,581	3,519.8	791,288
64		2,309.1	3.5791	20.65	13.88	4,087.1	918,818	4,525.8	1,017,448	3,228.8	725,866	3,575.4	803,784
65		2,381.8	3.6918	21.30	14.31	4,215.8	947,746	4,668.3	1,049,482	3,330.5	748,720	3,688.0	829,091

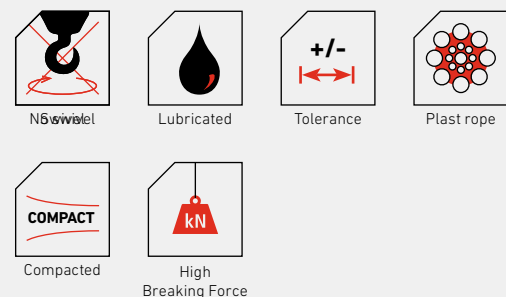
Product specifications are subject to change without notice or obligation. The shown drawings or cross sections are only for illustrative purposes; the images can vary depending on requested diameter and current status of technical development. This table is for reference only. Additional sizes available upon request.

CASAR VERSAPLAST M

- Rotation resistant
- Fully lubricated
- Plastic layer between steel core and outer strands
- Extremely high breaking force
- Good resistance to drum crushing
- Available in ordinary (regular) lays or langs lay
- Available with plastic layer or without

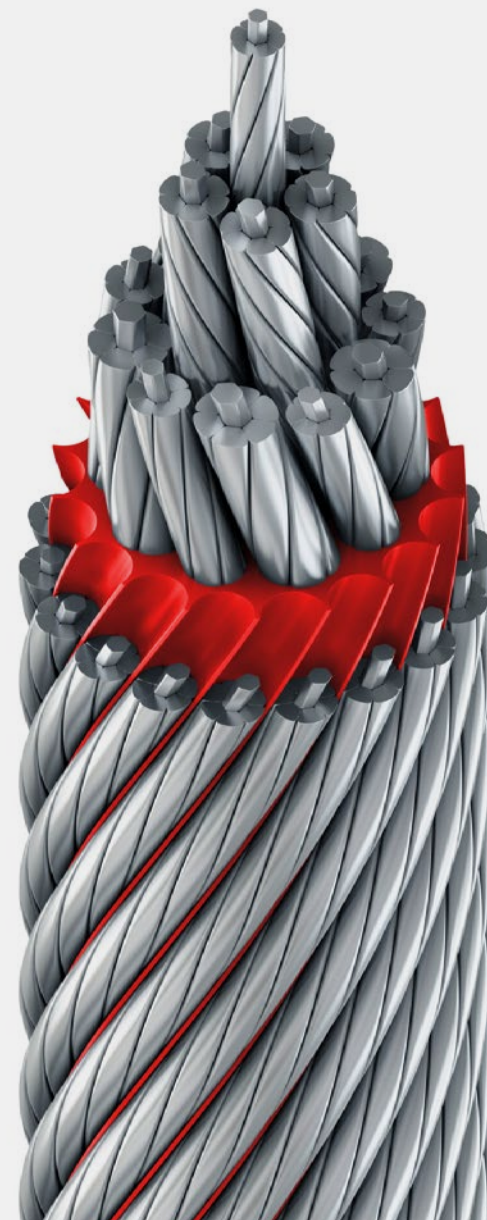


PROPERTIES



APPLICATIONS

Advanced hoist rope for drum, koepe friction winder and particularly shaft sinking applications, where rotation-resistant ropes are required. Rope design and manufacturing parameters are adjusted according to the application, i.e. Versaplast MD and Versaplast MF. The Versaplast M with compacted strands is a flexible rope that offers a high fatigue resistance as well as a good resistance to drum crushing.



Nominal Diameter	metallic area		Weight		Aggregate Breaking Force				Minimum Breaking Force				
					1770 N/mm ²		1960 N/mm ²		1770 N/mm ²		1960 N/mm ²		
mm	inch	mm ²	Sqin	kg/m	lb/ft	kN	lbs	kN	lbs	kN	lbs	kN	lbs
20		224.1	0.3474	1.95	1.31	396.7	89,172	440.2	98,964	333.2	74,905	374.2	84,120
21		246.6	0.3822	2.15	1.44	436.5	98,125	485.1	109,055	366.6	82,425	412.2	92,659
22		270.5	0.4193	2.35	1.58	478.8	107,635	531.7	119,542	402.2	90,414	452.0	101,610
	7/8	274.1	0.4249	2.39	1.60	485.2	109,068	537.2	120,775	407.5	91,617	458.0	102,962
23		296.2	0.4591	2.58	1.73	524.3	117,861	582.1	130,866	440.4	99,004	494.8	111,236
24		323.0	0.5007	2.82	1.89	571.7	128,525	635.6	142,895	480.2	107,961	540.3	121,461
25		351.0	0.5441	3.06	2.06	621.3	139,667	690.7	155,276	521.9	117,320	587.1	131,985
	1	356.4	0.5524	3.11	2.09	630.8	141,816	698.5	157,039	529.9	119,125	595.4	133,851
26		377.0	0.5844	3.28	2.21	667.3	150,013	745.0	167,482	560.5	126,011	634.2	142,584
27		409.0	0.6340	3.58	2.40	723.9	162,746	804.2	180,789	608.1	136,707	683.6	153,670
28		439.6	0.6814	3.83	2.57	778.1	174,922	863.6	194,140	653.6	146,934	734.0	165,019
	1 1/8	458.4	0.7105	4.01	2.69	811.4	182,403	898.5	201,983	681.5	153,218	768.3	172,721
29		470.1	0.7287	4.11	2.76	832.1	187,058	923.6	207,623	698.9	157,129	790.0	177,599
30		505.6	0.7837	4.41	2.97	894.9	201,184	995.7	223,838	751.7	168,995	846.3	190,262
	1 1/4	560.1	0.8682	4.89	3.28	991.4	222,870	1,097.8	246,794	832.8	187,211	930.0	209,072
32		571.6	0.8860	5.00	3.36	1,011.7	227,446	1,129.0	253,800	849.9	191,055	959.6	215,730
34		644.1	0.9984	5.64	3.79	1,140.1	256,295	1,268.3	285,129	957.6	215,288	1,079.0	242,569
	1 3/8	685.7	1.0628	5.99	4.02	1,213.7	272,848	1,344.0	302,137	1,015.1	228,194	1,146.0	257,631
36		731.2	1.1334	6.36	4.27	1,294.2	290,953	1,437.1	323,067	1,087.1	244,401	1,221.0	274,492
38	1 1/2	803.7	1.2457	7.03	4.73	1,422.5	319,802	1,589.0	357,215	1,194.9	268,633	1,352.0	303,942
40		889.6	1.3789	7.77	5.22	1,574.6	353,982	1,756.2	394,800	1,322.7	297,345	1,495.0	336,094
	1 5/8	958.8	1.4861	8.38	5.63	1,697.1	381,518	1,879.2	422,472	1,418.4	318,874	1,602.0	360,144
42		981.7	1.5216	8.57	5.76	1,737.6	390,630	1,935.5	435,118	1,459.6	328,129	1,645.0	369,811
44		1,087.5	1.6856	9.47	6.36	1,924.9	432,729	2,131.5	479,180	1,623.0	364,857	1,818.0	408,703
	1 3/4	1,102.1	1.7082	9.61	6.46	1,950.6	438,523	2,160.0	485,596	1,638.5	368,359	1,838.0	413,199
46		1,198.2	1.8572	10.43	7.01	2,120.8	476,778	2,347.9	527,825	1,781.5	400,493	1,995.0	448,494
	1 7/8	1,257.3	1.9488	10.96	7.37	2,225.4	500,294	2,464.3	553,998	1,869.4	420,247	2,095.0	470,975
48		1,311.1	2.0322	11.43	7.68	2,320.6	521,702	2,569.8	577,704	1,949.3	438,230	2,184.0	490,983
50		1,399.6	2.1694	12.15	8.17	2,477.3	556,917	2,743.2	616,699	2,080.9	467,811	2,331.0	524,030
	2	1,438.7	2.2300	12.54	8.43	2,546.5	572,476	2,819.9	633,928	2,139.1	480,880	2,400.0	539,541
52		1,529.7	2.3710	13.30	8.94	2,707.6	608,686	2,998.2	674,025	2,274.4	511,296	2,548.0	572,813
54	2 1/8	1,662.3	2.5766	14.48	9.73	2,942.3	661,449	3,258.1	732,452	2,437.4	547,956	2,731.0	613,953
56		1,771.0	2.7451	15.48	10.40	3,134.7	704,702	3,471.2	780,348	2,621.2	589,274	2,854.0	641,605
	2 1/4	1,854.8	2.8749	16.23	10.91	3,283.0	738,047	3,635.4	817,272	2,730.1	613,747	2,981.0	670,155
58		1,906.0	2.9543	16.65	11.19	3,373.6	758,420	3,735.8	839,832	2,811.8	632,121	3,063.0	688,590
60		2,055.0	3.1853	17.96	12.07	3,637.4	817,709	4,027.8	905,485	3,009.1	676,480	3,293.0	740,296
	2 3/8	2,053.0	3.1822	17.95	12.06	3,633.8	816,913	4,023.9	904,604	3,041.8	683,826	3,335.0	749,738
62		2,163.9	3.3540	18.93	12.72	3,830.1	861,041	4,241.2	953,469	3,213.1	722,330	3,477.0	781,661
	2 1/2	2,272.4	3.5222	19.86	13.34	4,022.1	904,215	4,453.9	1,001,277	3,370.4	757,700	3,652.0	821,002
64		2,334.0	3.6177	20.40	13.71	4,131.2	928,726	4,574.6	1,028,420	3,423.8	769,710	3,750.0	843,033

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SHARING KNOW-HOW ON HIGH-PERFORMANCE ROPES

Rope institutes, mines and Casar are working closely together to improve rope performance and service life.

High-performance hoisting ropes from CASAR are understood by our customers worldwide as the most technically advanced solution. As a result, it is of great importance for us to present this technology and expertise to scientific learning and research at universities in the context of guest lectures. Our guest speakers regularly take part in various global events, including the annual "Mining and Oil Electromechanics" conference. This international conference is hosted by the Institute for Safety and Health and the Mining and Petroleum Faculty of the National Research Polytechnic University (PNRPU). In addition to the students from the city of Perm there is also a special audience from industry and mining from the entire CIS region and Eastern Europe.

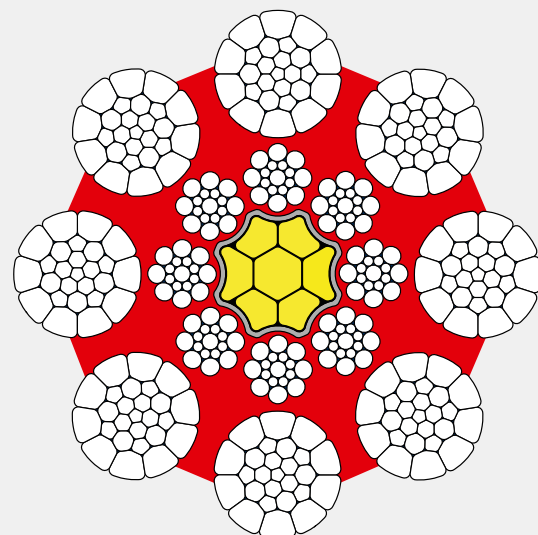
In cooperation with the PNRPU, the regional rope center and the Russian mining company JSC Uralkali, the production capacity and service life of the CASAR hoisting ropes are also regularly discussed. Uralkali is the world leader in potash production for the international fertilizer market and has been operating a large number of hoisting machines for several mines and shafts with our CASAR high-performance hoisting ropes, mainly the CASAR Turboplast MD Ø63mm, for several years

Our Turboplast MD is regularly measured with various products from our market competitors, which essentially correspond to the construction 8xK31WS. The comparisons are evaluated during and after operation by the Mining and Oil Faculty of the PNRPU, the regional rope center and Uralkali and presented at the annual "Mining and Oil Electromechanics" conference. Thanks to these extremely detailed investigations, it can be determined that the Turboplast MD shows, in addition to the unrivalled overall service life, a much more stable wear curve without accelerated or even sudden damage patterns. Such a level of performance offers the mine not only financial savings in operation, but also a special level of reliability and, above all, extraordinary operational safety. In addition, the company is making its contribution to sustainability and environmental protection by partially doubling the service life of the rope and thus reducing material consumption.



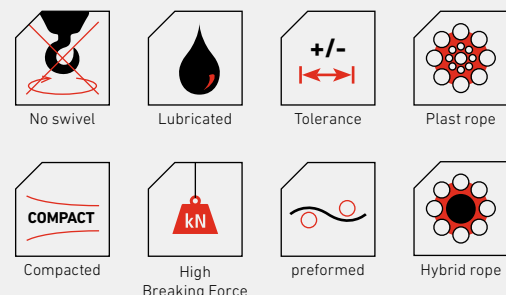
CASAR TURBOLITE M

- New Innovation
- High performance mining rope
- Lightest hybrid mine hoist rope worldwide
- Best strength to weight ratio hoist rope on the market
- High strength fiber core for increased strength and resistance to bending fatigue
- Minimized stretch compared to other fiber core hoist ropes
- Plastic layer between core and outer strands
- Available in ordinary (regular) lay or langs lay



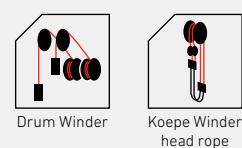
INNOVATIVE DESIGN

PROPERTIES



APPLICATIONS

Our latest innovation by Union, one of the two production families within WireCo WorldGroup. The steel and synthetic rope technology designed to our high performance hybrid rope CASAR Turbolite M. With the combination of steel and synthetic components, this innovative design offers a high breaking force, excellent fatigue as well as very good crushing and wear resistance. This makes our CASAR Turbolite M the future product for deep mining applications where the rope weight becomes a limitation factor for the hoisting capacity.

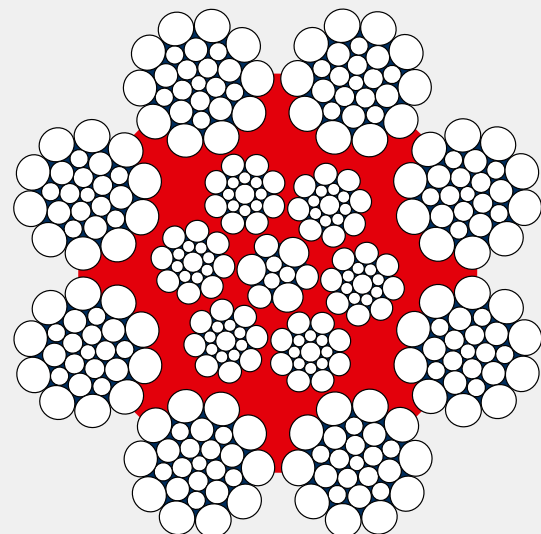


Nominal Diameter		metallic area		Weight		Aggregate Breaking Force				Minimum Breaking Force			
						1770 N/mm ²		1960 N/mm ²		1770 N/mm ²		1960 N/mm ²	
mm	inch	mm ²	Sqin	kg/m	lb/ft	kN	lbs	kN	lbs	kN	lbs	kN	lbs
20		191.8	0.2973	1.67	1.12	339.5	76,320	375.9	84,512	310.0	69,691	343.2	77,155
21		211.4	0.3277	1.85	1.24	374.2	84,119	414.3	93,149	341.7	76,818	378.4	85,068
22		232.0	0.3596	2.03	1.36	410.6	92,316	454.7	102,226	375.1	84,326	415.3	93,364
23		253.6	0.3931	2.21	1.49	448.9	100,911	497.1	111,743	409.9	92,150	453.9	102,041
24		276.1	0.4280	2.41	1.62	488.7	109,864	541.2	121,657	446.4	100,355	494.3	111,124
25		299.6	0.4644	2.61	1.75	530.3	119,215	587.2	132,012	484.3	108,875	536.3	120,566
26		324.1	0.5024	2.83	1.90	573.7	128,964	635.2	142,807	523.9	117,778	580.1	130,412
27		349.5	0.5417	3.05	2.05	618.6	139,071	685.0	153,999	564.9	126,995	625.6	140,641
28		375.8	0.5825	3.28	2.20	665.2	149,536	736.6	165,588	607.6	136,595	672.8	151,252
29		403.2	0.6250	3.52	2.37	713.7	160,439	790.3	177,661	651.7	146,509	721.7	162,245
30		431.4	0.6687	3.77	2.53	763.6	171,660	845.5	190,087	697.4	156,782	772.3	173,621
31		460.7	0.7141	4.03	2.71	815.4	183,319	903.0	202,997	744.7	167,416	824.7	185,401
32		490.9	0.7609	4.29	2.88	868.9	195,336	962.2	216,304	793.5	178,387	878.7	197,541
33		522.0	0.8091	4.56	3.06	923.9	207,711	1,023.1	230,008	843.9	189,717	934.5	210,085
34		554.2	0.8590	4.85	3.26	980.9	220,524	1,086.2	244,196	895.8	201,385	992.0	223,012
35		587.2	0.9102	5.13	3.45	1,039.3	233,655	1,150.9	258,737	949.3	213,412	1,051.2	236,320
36		621.3	0.9630	5.43	3.65	1,099.7	247,224	1,217.7	273,762	1,004.3	225,777	1,112.1	250,011
37		656.3	1.0173	5.73	3.85	1,161.7	261,151	1,286.3	289,184	1,060.9	238,501	1,174.8	264,107
38		692.2	1.0729	6.05	4.07	1,225.2	275,436	1,356.7	305,002	1,119.0	251,562	1,239.1	278,562
39		729.1	1.1301	6.37	4.28	1,290.5	290,119	1,429.0	321,262	1,178.7	264,984	1,305.2	293,422
40		767.0	1.1889	6.7	4.50	1,357.6	305,200	1,503.3	337,961	1,239.9	278,742	1,373.0	308,664
41		805.8	1.2490	7.04	4.73	1,426.3	320,639	1,579.4	355,058	1,302.7	292,860	1,442.5	324,288
42		845.6	1.3107	7.38	4.96	1,496.7	336,476	1,657.4	372,595	1,367.0	307,315	1,513.7	340,295
43		886.4	1.3739	7.75	5.21	1,568.9	352,711	1,737.3	390,572	1,432.9	322,130	1,586.7	356,706
44		928.1	1.4386	8.11	5.45	1,642.7	369,304	1,819.1	408,946	1,500.3	337,282	1,661.3	373,477
45		970.7	1.5046	8.48	5.70	1,718.1	386,255	1,902.6	427,717	1,569.2	352,772	1,737.7	390,652
46		1,014.4	1.5723	8.86	5.95	1,795.5	403,644	1,988.2	446,973	1,639.8	368,643	1,815.8	408,210
47		1,058.9	1.6413	9.25	6.22	1,874.3	421,351	2,075.4	466,581	1,711.8	384,830	1,895.6	426,150
48		1,104.5	1.7120	9.65	6.48	1,955.0	439,496	2,164.8	486,673	1,785.5	401,398	1,977.1	444,472
49		1,151.0	1.7841	10.05	6.75	2,037.3	457,999	2,256.0	507,162	1,860.6	418,281	2,060.4	463,199
50		1,198.4	1.8575	10.47	7.04	2,121.2	476,860	2,348.9	528,048	1,937.3	435,524	2,145.3	482,285
51		1,246.9	1.9327	10.89	7.32	2,207.0	496,159	2,443.9	549,419	2,015.6	453,127	2,232.0	501,776
52		1,296.2	2.0091	11.33	7.61	2,294.3	515,776	2,540.6	571,141	2,095.4	471,067	2,320.4	521,649
53		1,346.6	2.0872	11.76	7.90	2,383.5	535,831	2,639.3	593,349	2,176.8	489,366	2,410.5	541,905
54		1,397.9	2.1667	12.21	8.20	2,474.3	556,244	2,739.9	615,953	2,259.7	508,003	2,502.3	562,542
55		1,450.1	2.2477	12.67	8.51	2,566.7	577,015	2,842.2	638,954	2,344.2	527,000	2,595.8	583,562
56		1,503.3	2.3301	13.13	8.82	2,660.8	598,184	2,946.5	662,395	2,430.2	546,333	2,691.1	604,986
57		1,557.5	2.4141	13.61	9.15	2,756.8	619,751	3,052.7	686,277	2,517.8	566,027	2,788.0	626,770
58		1,612.6	2.4995	14.09	9.47	2,854.3	641,676	3,160.7	710,556	2,606.9	586,057	2,886.7	648,959
59		1,668.7	2.5865	14.58	9.80	2,953.6	663,999	3,270.7	735,275	2,697.6	606,447	2,987.1	671,530
60		1,725.8	2.6750	15.08	10.13	3,054.7	686,719	3,382.6	760,435	2,789.8	627,175	3,089.2	694,483

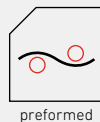
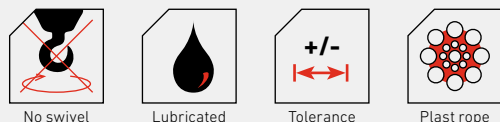
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CASAR STRATOPLAST M

- High performance mining rope
- 8-strand construction made out of conventional strands
- Fully lubricated
- Plastic layer between steel core and outer strands
- High breaking force
- Very flexible
- Designed to have a specific unit weight
- Available in ordinary (regular) lay or langs lay



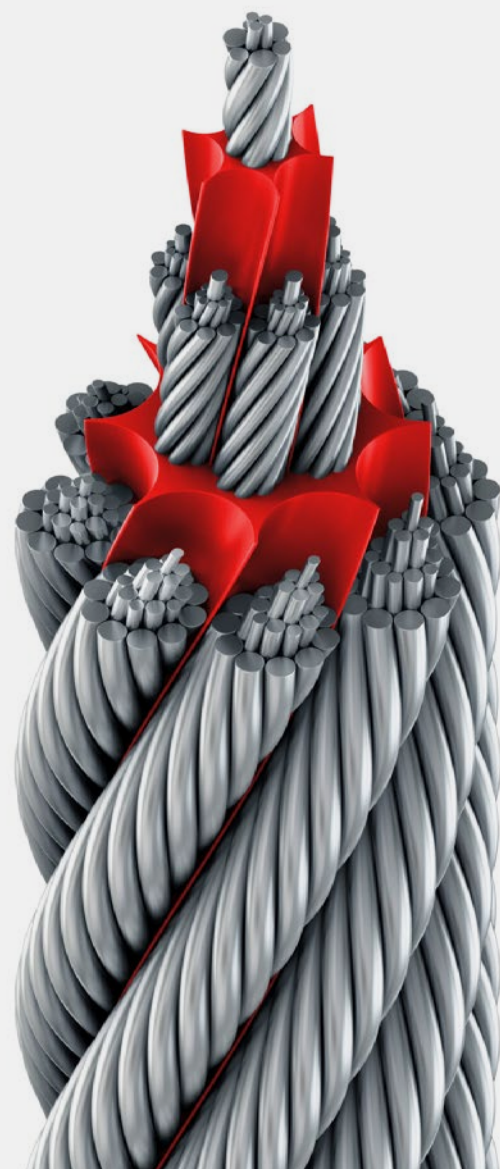
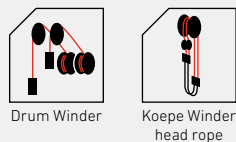
PROPERTIES



APPLICATIONS

High performance hoist rope suitable for a wide range of applications. Rope design and manufacturing parameters are adjusted according to the application, i.e. Stratoplast MD and Stratoplast MF. The Stratoplast M with conventional strands offers a high breaking force with a moderate rope weight, which provides a special suitability for koepe friction winder head rope applications where ropes with compacted strands are too heavy.

Less recommended for multi-layer drum winder applications.

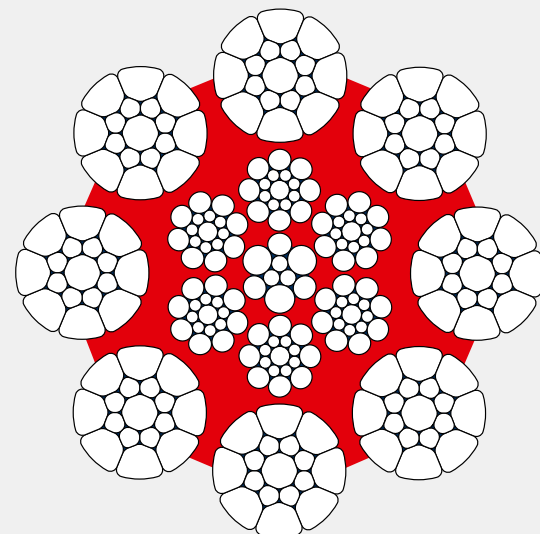


Nominal Diameter		metallic area		Weight		Aggregate Breaking Force				Minimum Breaking Force			
						1770 N/mm ²		1960 N/mm ²		1770 N/mm ²		1960 N/mm ²	
mm	inch	mm ²	Sqin	kg/m	lb/ft	kN	lbs	kN	lbs	kN	lbs	kN	lbs
20		191.0	0.2961	1.67	1.13	338.1	76,005	374.4	84,163	290.4	65,296	321.6	72,305
21		210.6	0.3264	1.85	1.24	372.7	83,795	412.8	92,790	320.2	71,988	354.6	79,716
22		231.1	0.3582	2.03	1.36	409.1	91,966	453.0	101,838	351.4	79,008	389.2	87,489
	7/8	235.9	0.3656	2.07	1.39	417.5	93,856	462.3	103,931	358.7	80,632	397.2	89,287
23		252.6	0.3915	2.21	1.49	447.1	100,516	495.1	111,306	384.1	86,353	425.4	95,623
24		275.1	0.4263	2.41	1.62	486.8	109,447	539.1	121,195	418.2	94,026	463.1	104,119
25		298.5	0.4626	2.62	1.76	528.3	118,757	585.0	131,505	453.8	102,024	502.5	112,976
	1	308.1	0.4775	2.70	1.81	545.3	122,588	603.8	135,747	468.5	105,315	518.8	116,620
26		322.8	0.5003	2.83	1.90	571.4	128,448	632.7	142,236	490.9	110,350	543.6	122,195
27		348.1	0.5396	3.05	2.05	616.2	138,518	682.3	153,388	529.3	119,001	586.2	131,775
28		374.4	0.5803	3.28	2.21	662.6	148,969	733.8	164,960	569.3	127,979	630.4	141,717
	1 1/8	389.9	0.6044	3.42	2.30	690.1	155,150	764.2	171,805	592.9	133,290	656.5	147,598
29		401.6	0.6225	3.52	2.37	710.8	159,800	787.1	176,953	610.7	137,284	676.2	152,021
30		429.8	0.6661	3.77	2.53	760.7	171,010	842.3	189,368	653.5	146,915	723.7	162,686
31		458.9	0.7113	4.02	2.70	812.3	182,601	899.4	202,202	697.8	156,873	772.7	173,712
	1 1/4	481.4	0.7461	4.22	2.84	852.0	191,544	943.5	212,105	732.0	164,555	810.6	182,219
32		489.0	0.7579	4.29	2.88	865.5	194,572	958.4	215,458	743.6	167,157	823.4	185,100
33		520.0	0.8060	4.56	3.06	920.4	206,923	1,019.2	229,135	790.7	177,767	875.6	196,850
34		552.0	0.8556	4.84	3.25	977.1	219,653	1,082.0	243,232	839.4	188,704	929.5	208,961
	1 3/8	582.5	0.9028	5.11	3.43	1,031.0	231,768	1,141.6	256,647	885.7	199,112	980.8	220,485
35		585.0	0.9067	5.13	3.45	1,035.4	232,764	1,146.5	257,750	889.5	199,968	985.0	221,433
36		618.9	0.9592	5.43	3.65	1,095.4	246,255	1,213.0	272,689	941.1	211,558	1,042.1	234,267
37		653.7	1.0133	5.73	3.85	1,157.1	260,126	1,281.3	288,049	994.1	223,474	1,100.8	247,463
38		689.5	1.0688	6.04	4.06	1,220.5	274,377	1,351.5	303,830	1,048.5	235,717	1,161.1	261,020
	1 1/2	693.2	1.0744	6.08	4.08	1,226.9	275,823	1,358.6	305,431	1,054.0	236,959	1,167.2	262,396
39		726.3	1.1258	6.37	4.28	1,285.6	289,008	1,423.6	320,031	1,104.4	248,287	1,223.0	274,939
40		764.0	1.1843	6.70	4.50	1,352.3	304,019	1,497.5	336,653	1,161.8	261,182	1,286.5	289,219
41		802.7	1.2442	7.04	4.73	1,420.8	319,410	1,573.3	353,696	1,220.6	274,405	1,351.6	303,861
	1 5/8	813.5	1.2610	7.13	4.79	1,439.9	323,709	1,594.5	358,457	1,237.0	278,098	1,369.8	307,951
42		842.3	1.3056	7.38	4.96	1,491.0	335,181	1,651.0	371,160	1,280.9	287,954	1,418.4	318,864
43		882.9	1.3686	7.74	5.20	1,562.8	351,332	1,730.6	389,045	1,342.6	301,829	1,486.7	334,229
44		924.5	1.4329	8.10	5.45	1,636.3	367,863	1,812.0	407,351	1,405.8	316,031	1,556.7	349,955
	1 3/4	943.5	1.4624	8.27	5.56	1,670.0	375,425	1,849.2	415,725	1,434.7	322,528	1,588.7	357,150
45		967.0	1.4988	8.48	5.70	1,711.6	384,774	1,895.3	426,077	1,470.4	330,559	1,628.2	366,043
46		1,010.4	1.5662	8.86	5.95	1,788.5	402,065	1,980.5	445,224	1,536.5	345,414	1,701.4	382,492
47		1,054.8	1.6350	9.25	6.21	1,867.1	419,736	2,067.5	464,792	1,604.0	360,595	1,776.2	399,303
	1 7/8	1,083.1	1.6788	9.49	6.38	1,917.1	430,973	2,122.9	477,236	1,647.0	370,249	1,823.7	409,993
48		1,100.2	1.7053	9.64	6.48	1,947.4	437,787	2,156.4	484,781	1,673.0	376,103	1,852.6	416,475
49		1,146.5	1.7771	10.05	6.75	2,029.4	456,218	2,247.2	505,191	1,743.4	391,937	1,930.6	434,009
50		1,193.8	1.8504	10.46	7.03	2,113.0	475,029	2,339.9	526,021	1,815.3	408,098	2,010.2	451,905
	2	1,232.3	1.9101	10.80	7.26	2,181.2	490,352	2,415.3	542,988	1,873.9	421,261	2,075.0	466,481
51		1,242.0	1.9252	10.89	7.32	2,198.4	494,220	2,434.4	547,272	1,888.6	424,585	2,091.4	470,162
52		1,291.2	2.0014	11.32	7.61	2,285.5	513,791	2,530.8	568,944	1,963.4	441,398	2,174.2	488,780
53		1,341.4	2.0791	11.76	7.90	2,374.2	533,743	2,629.1	591,037	2,039.7	458,538	2,258.6	507,760
54	2 1/8	1,391.2	2.1563	12.19	8.19	2,462.4	553,561	2,726.7	612,983	2,115.4	475,564	2,342.5	526,614
55		1,444.5	2.2390	12.66	8.51	2,556.8	574,785	2,831.2	636,485	2,196.5	493,798	2,432.3	546,805
56		1,497.5	2.3211	13.13	8.82	2,650.6	595,877	2,935.1	659,841	2,277.1	511,918	2,521.6	566,869
57	2 1/4	1,559.6	2.4175	13.67	9.19	2,760.6	620,601	3,056.9	687,220	2,371.6	533,159	2,626.2	590,390
58		1,606.4	2.4899	14.08	9.46	2,843.3	639,199	3,148.5	707,814	2,442.7	549,136	2,704.9	608,083
59		1,662.3	2.5765	14.57	9.79	2,942.2	661,431	3,258.0	732,432	2,527.6	568,235	2,799.0	629,232
60		1,719.1	2.6646	15.07	10.13	3,042.8	684,042	3,369.4	757,470	2,614.0	587,660	2,894.6	650,743
	2 3/8	1,737.8	2.6935	15.23	10.24	3,075.8	691,472	3,406.4	765,698	2,642.4	594,044	2,926.1	657,811
61		1,776.9	2.7541	15.58	10.47	3,145.0	707,033	3,482.6	782,930	2,701.9	607,412	2,991.9	672,615
62		1,835.6	2.8452	16.09	10.81	3,249.0	730,405	3,597.8	808,810	2,791.2	627,491	3,090.8	694,849
63		1,895.3	2.9377	16.61	11.16	3,354.7	754,156	3,714.8	835,111	2,882.0	647,896	3,191.3	717,444
	2 1/2	1,925.5	2.9845	16.88	11.34	3,408.1	766,174	3,774.0	848,419	2,927.9	658,220	3,242.2	728,877
64		1,955.9	3.0317	17.15	11.52	3,462.0	778,288	3,833.6	861,833	2,974.2	668,627	3,293.5	740,400
65		2,017.5	3.1272	17.69	11.88	3,571.0	802,799	3,954.4	888,975	3,067.9	689,685	3,397.2	763,719

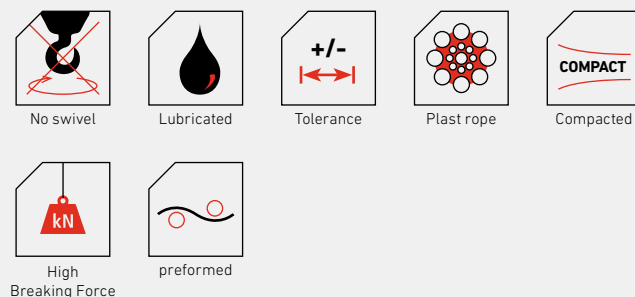
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CASAR DUROPLAST M

- High performance mining rope
- 8-strand construction with compacted outer strands
- Fully lubricated
- Plastic layer between steel core and outer strands
- Very high breaking force
- Excellent resistance to abrasion
- Available in ordinary (regular) lay or langs lay

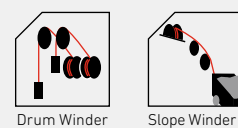


PROPERTIES



APPLICATIONS

High performance hoist rope with a very high resistance against abrasion and drum crushing. Our CASAR Duroplast MD is particularly developed for heavy duty, multi-layer drum winder applications as well as incline haulage or conveyor drive applications. In addition, the compacted strands with maximized outer wire sizes offer an increased resistance against a corrosive environment.

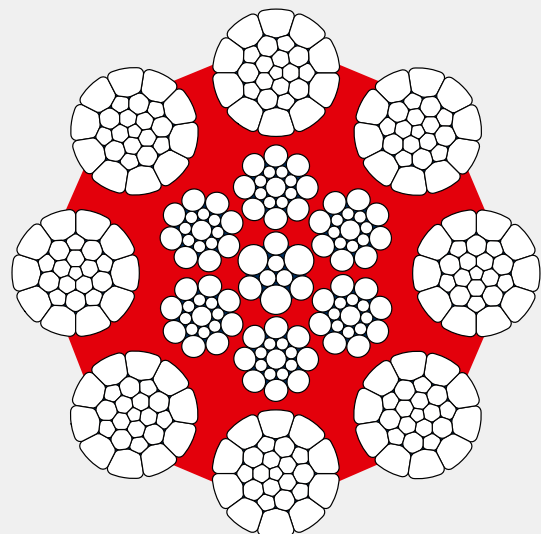


Nominal Diameter	metallic area		Weight		Aggregate Breaking Force				Minimum Breaking Force					
	mm	inch	mm ²	Sqin	kg/m	lb/ft	1770 N/mm ²		1960 N/mm ²		1770 N/mm ²		1960 N/mm ²	
							kN	lbs	kN	lbs	kN	lbs	kN	lbs
20			204.7	0.3173	1.78	1.20	362.3	81,453	401.2	90,196	303.3	68,192	335.9	75,512
21			225.7	0.3498	1.96	1.32	399.5	89,809	442.4	99,449	334.5	75,188	370.4	83,259
22			247.7	0.3839	2.16	1.45	438.4	98,563	485.5	109,143	367.1	82,517	406.5	91,374
	7/8		252.8	0.3918	2.20	1.48	447.4	100,589	495.5	111,387	374.6	84,213	414.8	93,253
23			270.8	0.4197	2.36	1.59	479.3	107,755	530.8	119,321	401.3	90,212	444.4	99,896
24			294.8	0.4569	2.56	1.72	521.8	117,304	577.8	129,896	436.8	98,207	483.7	108,749
25			319.9	0.4958	2.78	1.87	566.2	127,292	627.0	140,956	474.0	106,569	524.9	118,008
	1		330.2	0.5118	2.87	1.93	584.5	131,398	647.2	145,503	489.3	110,006	541.9	121,815
26			346.0	0.5363	3.01	2.02	612.4	137,677	678.2	152,456	512.7	115,264	567.8	127,637
27			373.1	0.5783	3.25	2.18	660.4	148,461	731.3	164,397	552.9	124,291	612.2	137,633
28			401.3	0.6220	3.49	2.35	710.3	159,682	786.5	176,823	594.7	133,686	658.5	148,036
	1 1/8		418.0	0.6478	3.63	2.44	739.8	166,308	819.2	184,160	619.3	139,233	685.8	154,179
29			430.5	0.6673	3.75	2.52	762.0	171,301	843.8	189,689	637.9	143,413	706.4	158,808
30			460.7	0.7141	4.01	2.69	815.4	183,318	903.0	202,996	682.7	153,474	756.0	169,948
31			491.9	0.7624	4.28	2.88	870.7	195,733	964.1	216,744	728.9	163,867	807.2	181,458
	1 1/4		516.0	0.7998	4.49	3.02	913.3	205,318	1,011.3	227,358	764.6	171,892	846.7	190,344
32			524.1	0.8124	4.56	3.06	927.7	208,546	1,027.2	230,932	776.6	174,594	860.0	193,336
33			557.4	0.8640	4.85	3.26	986.6	221,796	1,092.5	245,605	826.0	185,688	914.6	205,620
34			591.7	0.9171	5.15	3.46	1,047.3	235,444	1,159.7	260,718	876.8	197,114	970.9	218,273
35			627.0	0.9719	5.46	3.67	1,109.8	249,491	1,228.9	276,272	929.1	208,874	1,028.9	231,295
	1 3/8		639.2	0.9907	5.57	3.74	1,131.3	254,325	1,252.7	281,626	947.1	212,921	1,048.8	235,777
36			663.4	1.0283	5.77	3.88	1,174.2	263,975	1,300.3	292,311	983.1	221,000	1,088.6	244,723
37			700.7	1.0861	6.10	4.10	1,240.2	278,817	1,373.4	308,746	1,038.3	233,425	1,149.8	258,482
38			739.1	1.1456	6.43	4.32	1,308.2	294,097	1,448.6	325,666	1,095.2	246,218	1,212.8	272,648
	1 1/2		743.0	1.1516	6.46	4.34	1,315.1	295,646	1,456.3	327,383	1,101.0	247,515	1,219.2	274,085
39			778.5	1.2067	6.77	4.55	1,377.9	309,774	1,525.9	343,027	1,153.6	259,343	1,277.4	287,182
40			819.0	1.2695	7.12	4.78	1,449.6	325,890	1,605.2	360,872	1,213.6	272,835	1,343.9	302,122
41			860.4	1.3336	7.49	5.03	1,522.9	342,363	1,686.4	379,114	1,275.0	286,627	1,411.8	317,394
42			902.9	1.3995	7.86	5.28	1,598.1	359,275	1,769.7	397,841	1,338.0	300,785	1,481.6	333,072
	1 5/8		872.0	1.3516	7.59	5.10	1,543.4	346,978	1,709.1	384,224	1,292.2	290,490	1,430.9	321,673
43			946.4	1.4669	8.23	5.53	1,675.1	376,584	1,854.9	417,008	1,402.4	315,276	1,553.0	349,119
44			990.9	1.5359	8.62	5.79	1,753.9	394,291	1,942.2	436,616	1,468.4	330,100	1,626.0	365,535
	1 3/4		1,011.3	1.5675	8.80	5.91	1,790.0	402,397	1,982.1	445,592	1,498.5	336,887	1,659.4	373,050
45			1,036.5	1.6066	9.02	6.06	1,834.6	412,436	2,031.5	456,708	1,535.9	345,291	1,700.8	382,356
46			1,083.1	1.6788	9.42	6.33	1,917.1	430,978	2,122.9	477,241	1,605.0	360,815	1,777.3	399,547
47			1,130.7	1.7526	9.84	6.61	2,001.3	449,919	2,216.2	498,215	1,675.5	376,672	1,855.4	417,106
	1 7/8		1,161.0	1.7995	10.10	6.79	2,054.9	461,964	2,275.5	511,554	1,720.4	386,757	1,905.1	428,273
48			1,179.3	1.8279	10.26	6.89	2,087.4	469,257	2,311.4	519,630	1,747.5	392,862	1,935.1	435,034
49			1,229.0	1.9050	10.69	7.18	2,175.3	489,034	2,408.8	541,529	1,821.2	409,419	2,016.7	453,368
50			1,279.6	1.9834	11.13	7.48	2,264.9	509,168	2,508.0	563,824	1,896.2	426,275	2,099.7	472,034

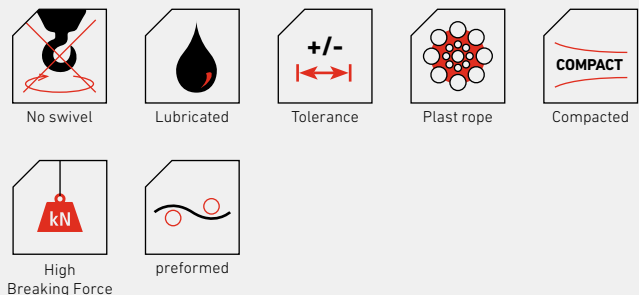
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CASAR TURBOPLAST M

- High performance mining rope
- 8-strand construction with compacted outer strands
- Fully lubricated
- Plastic layer between steel core and outer strands
- Very high breaking force
- Good resistance to drum crushing
- Available in ordinary (regular) lay or lang's lay



PROPERTIES



APPLICATIONS

High performance hoist rope for a wide range of drum and koepe friction winder applications. Rope design and manufacturing parameters are adjusted according to the application, i.e. Turboplast MD and Turboplast MF. Our CASAR Turboplast M with compacted strands offers an excellent fatigue resistance as well as a good resistance to drum crushing.



IMPROVED DESIGN

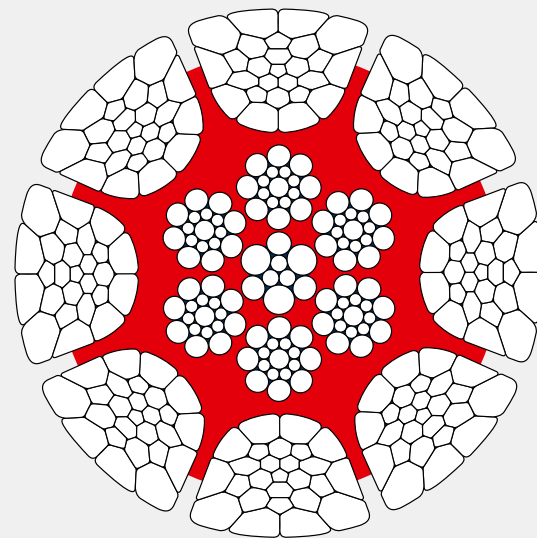


Nominal Diameter		metallic area		Weight		Aggregate Breaking Force				Minimum Breaking Force			
						1770 N/mm ²		1960 N/mm ²		1770 N/mm ²		1960 N/mm ²	
mm	inch	mm ²	Sqin	kg/m	lb/ft	kN	lbs	kN	lbs	kN	lbs	kN	lbs
20		207.0	0.3209	1.80	1.21	366.4	82,368	405.7	91,209	310.0	69,691	343.2	77,154
21		228.3	0.3539	1.99	1.34	404.1	90,843	447.5	100,595	341.7	76,817	378.4	85,068
22		250.5	0.3883	2.18	1.46	443.4	99,677	491.0	110,377	375.1	84,326	415.3	93,363
	7/8	255.6	0.3962	2.22	1.49	452.4	101,706	501.0	112,624	382.8	86,057	423.8	95,274
23		273.8	0.4244	2.38	1.60	484.6	108,948	536.6	120,643	409.9	92,149	453.9	102,041
24		298.1	0.4621	2.59	1.74	527.6	118,617	584.3	131,350	446.4	100,355	494.3	111,123
25		323.5	0.5014	2.81	1.89	572.6	128,724	634.1	142,542	484.3	108,875	536.3	120,565
	1	333.9	0.5175	2.90	1.95	591.0	132,863	654.4	147,125	499.9	112,382	553.5	124,432
26		349.9	0.5423	3.04	2.04	619.3	139,229	685.8	154,175	523.9	117,777	580.1	130,412
27		377.3	0.5848	3.28	2.20	667.8	150,132	739.5	166,248	564.9	126,995	625.6	140,640
28		405.8	0.6290	3.53	2.37	718.3	161,473	795.4	178,806	607.6	136,594	672.8	151,251
	1 1/8	422.6	0.6550	3.67	2.47	748.0	168,158	828.3	186,208	632.8	142,259	700.7	157,524
29		435.3	0.6747	3.79	2.55	770.5	173,211	853.2	191,804	651.7	146,508	721.7	162,245
30		465.8	0.7220	4.05	2.72	824.5	185,347	913.0	205,243	697.4	156,782	772.3	173,620
31		497.4	0.7710	4.33	2.91	880.4	197,921	974.9	219,167	744.7	167,415	824.7	185,400
	1 1/4	521.7	0.8086	4.54	3.05	923.4	207,591	1,022.5	229,874	781.1	175,598	865.0	194,460
32		530.0	0.8215	4.61	3.10	938.1	210,893	1,038.8	233,531	793.5	178,386	878.7	197,540
33		563.7	0.8737	4.90	3.29	997.7	224,303	1,104.9	248,381	843.9	189,716	934.5	210,084
34		598.3	0.9274	5.21	3.50	1,059.0	238,071	1,172.7	263,626	895.8	201,384	992.0	223,010
	1 3/8	631.2	0.9784	5.49	3.69	1,117.2	251,162	1,237.2	278,123	945.2	212,489	1,046.7	235,307
35		634.1	0.9829	5.52	3.71	1,122.4	252,316	1,242.8	279,401	949.3	213,411	1,051.2	236,319
36		670.5	1.0393	5.84	3.92	1,186.8	266,800	1,314.2	295,439	1,004.3	225,776	1,112.1	250,010
37		708.6	1.0983	6.16	4.14	1,254.2	281,960	1,388.9	312,227	1,060.9	238,500	1,174.8	264,105
38		747.4	1.1585	6.50	4.37	1,322.9	297,399	1,464.9	329,323	1,119.0	251,561	1,239.1	278,561
	1 1/2	751.3	1.1645	6.53	4.39	1,329.8	298,951	1,472.5	331,042	1,124.8	252,865	1,245.6	280,022
39		787.3	1.2203	6.85	4.60	1,393.5	313,276	1,543.1	346,904	1,178.7	264,982	1,305.2	293,421
40		828.1	1.2836	7.20	4.84	1,465.7	329,511	1,623.1	364,882	1,239.9	278,741	1,373.0	308,663
41		870.1	1.3487	7.57	5.09	1,540.1	346,223	1,705.4	383,388	1,302.7	292,859	1,442.5	324,287
	1 5/8	881.8	1.3668	7.67	5.15	1,560.8	350,879	1,728.3	388,544	1,320.2	296,793	1,461.9	328,648
42		913.0	1.4152	7.94	5.34	1,616.0	363,293	1,789.5	402,291	1,367.0	307,314	1,513.7	340,293
43		957.0	1.4834	8.33	5.60	1,693.9	380,802	1,875.7	421,679	1,432.9	322,129	1,586.7	356,704
44		1,002.1	1.5533	8.72	5.86	1,773.7	398,747	1,964.1	441,551	1,500.3	337,281	1,661.3	373,475
	1 3/4	1,022.7	1.5852	8.89	5.97	1,810.2	406,944	2,004.5	450,628	1,531.1	344,205	1,695.4	381,141
45		1,048.1	1.6246	9.12	6.13	1,855.1	417,051	2,054.3	461,820	1,569.2	352,770	1,737.7	390,650
46		1,095.2	1.6976	9.53	6.40	1,938.5	435,793	2,146.6	482,573	1,639.8	368,642	1,815.8	408,208
47		1,143.4	1.7723	9.95	6.69	2,023.8	454,972	2,241.1	503,811	1,711.8	384,828	1,895.6	426,148
	1 7/8	1,174.0	1.8197	10.21	6.86	2,078.0	467,148	2,301.0	517,294	1,757.6	395,124	1,946.3	437,546
48		1,192.5	1.8484	10.38	6.98	2,110.7	474,510	2,337.3	525,446	1,785.5	401,396	1,977.1	444,470
49		1,242.7	1.9262	10.81	7.26	2,199.6	494,485	2,435.7	547,565	1,860.6	418,279	2,060.4	463,196
50		1,303.7	2.0208	11.26	7.57	2,307.6	518,762	2,555.3	574,448	1,937.3	435,522	2,145.3	482,283
	2	1,345.7	2.0858	11.62	7.81	2,381.9	535,470	2,637.6	592,950	1,999.7	449,550	2,214.4	497,817
51		1,346.3	2.0868	11.71	7.87	2,383.0	535,709	2,638.7	593,214	2,015.6	453,125	2,232.0	501,773
52		1,399.6	2.1694	12.18	8.18	2,477.3	556,917	2,743.2	616,699	2,095.4	471,065	2,320.4	521,647
53		1,453.9	2.2535	12.65	8.50	2,573.4	578,524	2,849.6	640,625	2,176.8	489,364	2,410.5	541,902
	2 1/8	1,507.8	2.3371	13.11	8.81	2,668.8	599,971	2,955.3	664,375	2,257.6	507,529	2,500.0	562,022
54		1,509.3	2.3394	13.13	8.82	2,671.5	600,568	2,958.2	665,036	2,259.7	508,001	2,502.3	562,539
55		1,565.7	2.4268	13.62	9.15	2,771.3	623,010	3,068.8	689,887	2,344.2	526,997	2,595.8	583,559
56		1,623.2	2.5160	14.12	9.49	2,873.1	645,890	3,181.5	715,223	2,430.2	546,331	2,691.1	604,983
57		1,681.7	2.6066	14.63	9.83	2,976.6	669,168	3,296.1	741,000	2,517.8	566,024	2,788.0	626,767
	2 1/4	1,690.5	2.6203	14.70	9.88	2,992.2	672,670	3,313.4	744,877	2,531.0	568,991	2,802.6	630,049
58		1,741.2	2.6989	15.15	10.18	3,081.9	692,844	3,412.8	767,217	2,606.9	586,054	2,886.7	648,956
59		1,801.7	2.7926	15.68	10.54	3,189.0	716,918	3,531.3	793,875	2,697.6	606,444	2,987.1	671,527
60		1,863.3	2.8881	16.21	10.89	3,298.0	741,429	3,652.1	821,017	2,789.8	627,172	3,089.2	694,480
	2 3/8	1,883.5	2.9194	16.39	11.01	3,333.8	749,467	3,691.7	829,918	2,820.1	633,984	3,122.8	702,033
61		1,925.9	2.9851	16.75	11.26	3,408.8	766,338	3,774.8	848,601	2,883.6	648,259	3,193.0	717,815
62		1,989.6	3.0839	17.31	11.63	3,521.6	791,685	3,899.6	876,668	2,978.9	669,683	3,298.6	741,555
63		2,054.3	3.1842	17.87	12.01	3,636.1	817,430	4,026.4	905,177	3,075.8	691,467	3,405.8	765,654
	2 1/2	2,087.0	3.2349	18.16	12.20	3,694.0	830,442	4,090.5	919,585	3,124.8	702,483	3,460.1	777,861
64		2,120.0	3.2860	18.44	12.39	3,752.4	843,573	4,155.2	934,126	3,174.2	713,588	3,514.8	790,158
65		2,186.8	3.3895	19.02	12.78	3,870.6	870,153	4,286.1	963,560	3,274.1	736,047	3,625.5	815,045

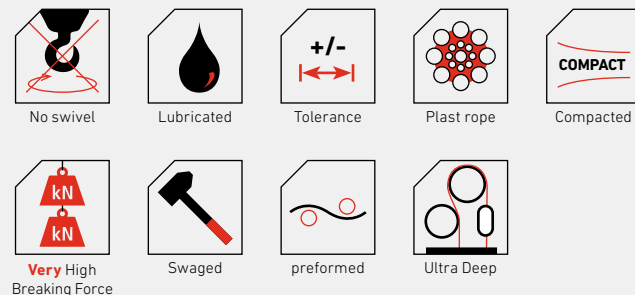
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CASAR TURBOFIT M

- High performance mining rope
- Swaged 8-strand construction with compacted outer strands
- Fully lubricated
- Plastic layer between steel core and outer strands
- Very High breaking force
- Excellent resistance to drum crushing
- Available in ordinary (regular) lay or lang's lay



PROPERTIES

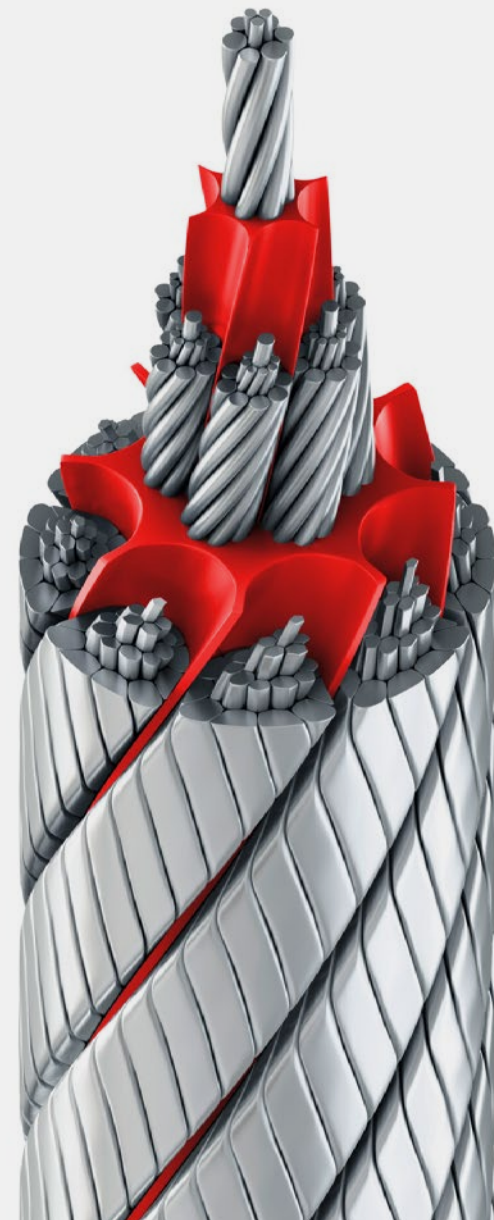
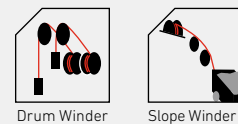


INNOVATIVE DESIGN

APPLICATIONS

High performance hoist rope particularly developed for heavy duty, multi-layer drum winder applications. Our CASAR Turbofit MD is cold swaged after manufacture which makes it a very durable rope design to provide an increased surface contact area and provides a maximum resistance against abrasion and crushing.

Less recommended for koepe friction winder applications.

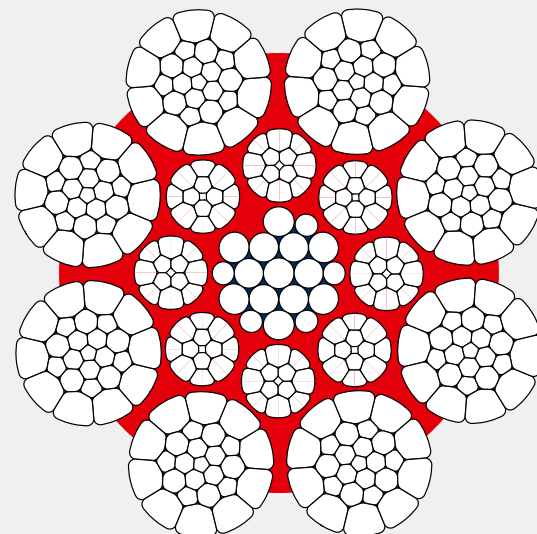


Nominal Diameter	metallic area		Weight		Aggregate Breaking Force				Minimum Breaking Force					
	mm	inch	mm ²	Sqin	kg/m	lb/ft	1770 N/mm ²		1960 N/mm ²		1770 N/mm ²		1960 N/mm ²	
							kN	lbs	kN	lbs	kN	lbs	kN	lbs
20			222.4	0.3447	1.93	1.30	393.6	88,496	435.9	97,995	338.5	76,098	374.8	84,258
21			245.2	0.3801	2.13	1.43	434.0	97,568	480.6	108,041	373.2	83,899	413.2	92,891
22			269.1	0.4171	2.34	1.57	476.3	107,078	527.4	118,572	409.6	92,082	453.5	101,951
		7/8	274.6	0.4256	2.39	1.61	486.1	109,279	538.3	121,010	418.0	93,975	462.8	104,047
23			294.1	0.4559	2.56	1.72	520.6	117,026	576.4	129,588	447.6	100,624	495.7	111,438
24			320.2	0.4963	2.79	1.87	566.8	127,411	627.6	141,088	487.4	109,572	539.7	121,329
25			347.4	0.5385	3.02	2.03	614.9	138,235	680.9	153,073	528.9	118,901	585.6	131,648
		1	358.6	0.5558	3.12	2.10	634.7	142,693	702.9	158,011	546.0	122,737	604.5	135,895
26			375.8	0.5825	3.27	2.20	665.2	149,535	736.6	165,587	572.0	128,591	633.4	142,394
27			405.3	0.6282	3.53	2.37	717.4	161,274	794.4	178,585	616.9	138,685	683.1	153,567
28			435.8	0.6755	3.79	2.55	771.4	173,410	854.2	192,025	663.4	149,138	734.6	165,145
		1 1/8	453.9	0.7035	3.95	2.65	803.4	180,605	889.6	199,992	690.9	155,326	765.1	171,997
29			467.5	0.7246	4.07	2.73	827.5	186,024	916.3	205,992	711.7	159,996	788.0	177,149
30			500.3	0.7755	4.35	2.92	885.5	199,075	980.6	220,445	761.6	171,214	843.3	189,581
31			534.2	0.8280	4.65	3.12	945.5	212,564	1,047.0	235,382	813.2	182,815	900.5	202,440
		1 1/4	560.4	0.8686	4.88	3.28	991.8	222,974	1,098.3	246,909	853.0	191,767	944.6	212,354
32			569.2	0.8823	4.95	3.33	1,007.5	226,491	1,115.6	250,804	866.5	194,797	959.5	215,704
33			605.4	0.9384	5.27	3.54	1,071.6	240,896	1,186.6	266,755	921.5	207,161	1,020.4	229,395
34			642.6	0.9960	5.59	3.76	1,137.4	255,698	1,259.5	283,146	978.2	219,908	1,083.2	243,513
35		1 3/8	681.0	1.0556	5.92	3.98	1,205.4	270,978	1,334.8	300,066	1,036.6	233,037	1,147.9	258,058
36			720.5	1.1168	6.27	4.21	1,275.3	286,695	1,412.2	317,471	1,096.7	246,548	1,214.4	273,008
37			761.0	1.1796	6.62	4.45	1,347.0	302,811	1,491.6	335,316	1,158.4	260,419	1,282.8	288,385
38			802.7	1.2442	6.98	4.69	1,420.8	319,404	1,573.3	353,690	1,221.9	274,694	1,353.1	304,189
39		1 1/2	845.5	1.3105	7.36	4.94	1,496.5	336,434	1,657.2	372,549	1,287.1	289,352	1,425.2	320,398
40			889.4	1.3786	7.74	5.20	1,574.2	353,903	1,743.2	391,892	1,353.9	304,369	1,499.3	337,056
41		1 5/8	934.5	1.4485	8.13	5.46	1,654.1	371,849	1,831.6	411,764	1,422.5	319,791	1,575.2	354,119
42			980.6	1.5199	8.53	5.73	1,735.7	390,192	1,922.0	432,077	1,492.7	335,572	1,652.9	371,587
43			1,027.9	1.5932	8.94	6.01	1,819.4	409,013	2,014.7	452,919	1,564.6	351,736	1,732.6	389,504
44			1,076.2	1.6681	9.36	6.29	1,904.9	428,233	2,109.4	474,201	1,638.2	368,282	1,814.1	407,826
		1 3/4	1,098.3	1.7024	9.56	6.42	1,944.0	437,037	2,152.7	483,950	1,671.9	375,854	1,851.4	416,210
45			1,125.7	1.7448	9.79	6.58	1,992.5	447,929	2,206.4	496,012	1,713.6	385,233	1,897.5	426,575
46			1,176.3	1.8233	10.23	6.88	2,082.1	468,064	2,305.5	518,308	1,790.6	402,543	1,982.8	445,751
47			1,228.0	1.9034	10.68	7.18	2,173.6	488,636	2,406.9	541,088	1,869.3	420,235	2,069.9	465,332
		1 7/8	1,260.9	1.9544	10.97	7.37	2,231.8	501,718	2,471.3	555,574	1,919.3	431,486	2,125.3	477,790
48			1,280.8	1.9852	11.14	7.49	2,267.0	509,645	2,510.4	564,353	1,949.6	438,287	2,158.9	485,340
49			1,334.7	2.0688	11.61	7.80	2,362.4	531,093	2,616.0	588,103	2,031.7	456,744	2,249.8	505,775
50			1,389.8	2.1542	12.09	8.12	2,459.9	553,018	2,724.0	612,381	2,115.5	475,583	2,342.6	526,637
		2	1,434.6	2.2236	12.48	8.39	2,539.3	570,856	2,811.9	632,134	2,183.7	490,924	2,418.2	543,625
51			1,445.9	2.2411	12.58	8.45	2,559.2	575,341	2,834.0	637,100	2,201.0	494,804	2,437.2	547,904
52			1,503.2	2.3300	13.08	8.79	2,660.7	598,141	2,946.3	662,348	2,288.1	514,385	2,533.7	569,598
53			1,561.5	2.4203	13.59	9.13	2,763.9	621,339	3,060.5	688,037	2,377.0	534,371	2,632.1	591,720
54		2 1/8	1,621.0	2.5126	14.10	9.48	2,869.2	645,015	3,177.2	714,254	2,467.5	554,716	2,732.4	614,268
55			1,681.6	2.6065	14.63	9.83	2,976.4	669,128	3,295.9	740,956	2,559.7	575,443	2,834.5	637,221
56			1,743.3	2.7021	15.17	10.19	3,085.6	693,680	3,416.9	768,142	2,653.7	596,575	2,938.5	660,601
57		2 1/4	1,806.1	2.7995	15.71	10.56	3,196.8	718,668	3,540.0	795,814	2,749.3	618,067	3,044.4	684,408
58			1,870.1	2.8987	16.27	10.93	3,310.1	744,135	3,665.4	824,014	2,846.6	639,941	3,152.2	708,643
59			1,935.1	2.9994	16.84	11.31	3,425.1	769,999	3,792.8	852,654	2,945.6	662,197	3,261.8	733,282
60			2,001.3	3.1020	17.41	11.70	3,542.3	796,341	3,922.5	881,824	3,046.3	684,835	3,373.3	758,348

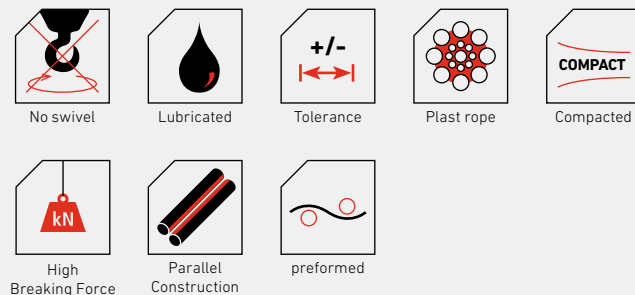
Product specifications are subject to change without notice or obligation. The shown drawings or cross sections are only for illustrative purposes; the images can vary depending on requested diameter and current status of technical development. This table is for reference only. Additional sizes available upon request.

CASAR PARAPLAST M

- High performance mining rope
- 8-strand construction with compacted outer strands
- Double parallel design
- Fully lubricated
- Plastic layer between steel core and outer strands
- Very high breaking force
- Good resistance to drum crushing
- Available in ordinary (regular) lay or lang's lay

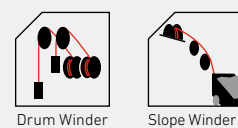


PROPERTIES



APPLICATIONS

High performance hoist rope particularly developed for heavy duty, multi-layer drum winder applications. Our CASAR Paraplast MD is a double parallel, very durable rope design to provide an excellent flexibility with a very high breaking force and a good resistance to drum crushing.

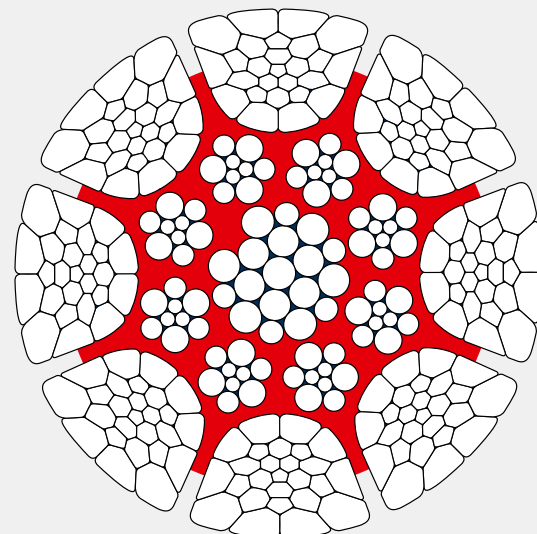


Nominal Diameter		metallic area		Weight		Aggregate Breaking Force				Minimum Breaking Force			
						1770 N/mm ²		1960 N/mm ²		1770 N/mm ²		1960 N/mm ²	
mm	inch	mm ²	Sqin	kg/m	lb/ft	kN	lbs	kN	lbs	kN	lbs	kN	lbs
20		220.1	0.3412	2.01	1.35	389.6	87,580	431.4	96,982	342.9	77,087	379.7	85,362
21		240.4	0.3726	2.20	1.48	425.5	95,658	471.2	105,926	374.5	84,191	414.7	93,228
22		264.8	0.4104	2.40	1.61	468.7	105,367	519.0	116,678	412.5	92,734	456.8	102,688
	7/8	270.2	0.4189	2.45	1.65	478.3	107,533	529.7	119,076	421.0	94,640	466.2	104,799
23		299.8	0.4647	2.64	1.77	530.6	119,294	587.6	132,100	467.0	104,986	517.1	116,255
24		325.7	0.5048	2.87	1.93	576.5	129,600	638.4	143,512	507.3	114,046	561.8	126,288
25		353.1	0.5473	3.11	2.09	625.0	140,503	692.1	155,585	550.0	123,645	609.0	136,918
	1	364.5	0.5650	3.21	2.16	645.1	145,035	714.4	160,603	567.7	127,633	628.7	141,334
26		383.9	0.5950	3.38	2.27	679.5	152,758	752.4	169,156	598.0	134,436	662.2	148,867
27		412.3	0.6391	3.63	2.44	729.8	164,059	808.1	181,670	642.1	144,350	711.0	159,845
28		441.0	0.6836	3.89	2.61	780.6	175,479	864.4	194,316	686.8	154,399	760.6	170,990
	1 1/8	459.3	0.7119	4.05	2.72	813.0	182,760	900.2	202,379	715.3	160,805	792.2	178,085
29		475.6	0.7372	4.18	2.81	841.8	189,247	932.2	209,561	740.8	166,538	820.3	184,415
30		512.5	0.7944	4.49	3.02	907.1	203,930	1,004.5	225,821	798.3	179,465	884.0	198,730
31		546.6	0.8473	4.78	3.21	967.5	217,507	1,071.4	240,855	841.7	189,222	921.4	207,139
	1 1/4	573.4	0.8888	5.01	3.37	1,014.9	228,158	1,123.8	252,650	882.9	198,488	966.5	217,283
32		580.4	0.8996	5.11	3.43	1,027.3	230,936	1,137.5	255,726	893.7	200,912	978.3	219,931
33		618.5	0.9587	5.45	3.66	1,094.7	246,108	1,212.3	272,527	952.4	214,108	1,042.5	234,363
34		650.8	1.0087	5.75	3.86	1,151.9	258,961	1,275.6	286,759	1,002.2	225,303	1,097.0	246,615
	1 3/8	686.7	1.0644	6.07	4.08	1,215.4	273,243	1,345.9	302,574	1,057.5	237,729	1,157.5	260,217
35		690.5	1.0702	6.11	4.11	1,222.1	274,746	1,353.3	304,239	1,063.3	239,039	1,163.9	261,655
36		732.0	1.1346	6.42	4.31	1,295.6	291,267	1,434.7	322,533	1,127.2	253,405	1,233.8	277,369
37		770.8	1.1947	6.78	4.56	1,364.3	306,706	1,510.7	339,630	1,186.9	266,826	1,299.2	292,072
38	1 1/2	817.0	1.2664	7.20	4.84	1,446.1	325,106	1,601.4	360,004	1,258.1	282,832	1,377.2	309,607
39		851.5	1.3199	7.58	5.09	1,507.2	338,834	1,669.0	375,206	1,311.3	294,792	1,435.3	322,668
40		909.7	1.4101	7.98	5.36	1,610.2	361,996	1,783.1	400,855	1,400.9	314,935	1,533.5	344,744
	1 5/8	968.7	1.5014	8.50	5.71	1,714.5	385,441	1,898.6	426,816	1,491.6	335,332	1,632.8	367,072
42		996.8	1.5450	8.78	5.90	1,764.3	396,623	1,953.6	439,198	1,534.9	345,059	1,680.1	377,701
44		1,098.4	1.7025	9.64	6.48	1,944.1	437,054	2,152.8	483,970	1,691.4	380,242	1,851.4	416,211
	1 3/4	1,121.0	1.7375	9.84	6.61	1,984.1	446,040	2,197.1	493,920	1,726.2	388,059	1,889.5	424,768
46		1,200.0	1.8600	10.54	7.08	2,124.1	477,506	2,352.1	528,764	1,847.9	415,424	2,022.8	454,743
	1 7/8	1,286.3	1.9938	11.30	7.59	2,276.8	511,839	2,521.2	566,782	1,980.8	445,293	2,168.2	487,440
48		1,306.4	2.0249	11.46	7.70	2,312.3	519,820	2,560.5	575,620	2,011.7	452,248	2,202.0	495,029
50		1,403.3	2.1751	12.52	8.41	2,483.8	558,374	2,750.4	618,312	2,160.9	485,790	2,365.3	531,740
51	2	1,453.8	2.2535	12.85	8.63	2,573.3	578,502	2,849.5	640,601	2,238.8	503,297	2,450.6	550,917
52		1,523.3	2.3612	13.46	9.05	2,696.3	606,156	2,985.8	671,223	2,345.8	527,355	2,567.7	577,252
53		1,582.5	2.4529	13.99	9.40	2,801.0	629,694	3,101.7	697,288	2,436.9	547,833	2,667.5	599,667
54	2 1/8	1,641.3	2.5439	14.51	9.75	2,905.0	653,075	3,216.9	723,179	2,527.4	568,175	2,766.5	621,934
55		1,704.2	2.6415	15.06	10.12	3,016.4	678,114	3,340.2	750,906	2,624.3	589,959	2,872.6	645,779
56		1,766.7	2.7384	15.61	10.49	3,127.1	702,997	3,462.8	778,460	2,720.6	611,607	2,978.0	669,476
57	2 1/4	1,840.0	2.8520	16.26	10.93	3,256.8	732,167	3,606.4	810,761	2,833.5	636,985	3,101.5	697,254
58		1,895.2	2.9375	16.75	11.26	3,354.4	754,108	3,714.5	835,057	2,918.4	656,074	3,194.5	718,149
59		1,961.1	3.0397	17.33	11.65	3,471.1	780,336	3,843.7	864,101	3,019.9	678,892	3,305.6	743,127
60		2,028.1	3.1436	17.92	12.04	3,589.8	807,012	3,975.1	893,640	3,123.1	702,100	3,418.6	768,531
	2 3/8	2,050.1	3.1777	18.12	12.18	3,628.8	815,778	4,018.3	903,348	3,157.0	709,727	3,455.7	776,879
61		2,096.3	3.2492	18.53	12.45	3,710.4	834,137	4,108.7	923,677	3,228.1	725,699	3,533.5	794,362
62		2,165.6	3.3566	19.14	12.86	3,833.1	861,709	4,244.5	954,209	3,334.8	749,687	3,650.3	820,620
63		2,236.0	3.4658	19.76	13.28	3,957.7	889,731	4,382.6	985,239	3,443.2	774,066	3,769.0	847,305
	2 1/2	2,271.6	3.5210	20.08	13.49	4,020.8	903,909	4,452.4	1,000,939	3,498.1	786,401	3,829.1	860,808
64		2,307.5	3.5767	20.39	13.70	4,084.4	918,200	4,522.8	1,016,764	3,553.4	798,834	3,889.6	874,417
65		2,380.2	3.6893	21.04	14.14	4,213.0	947,118	4,665.2	1,048,786	3,665.3	823,993	4,058.8	912,444

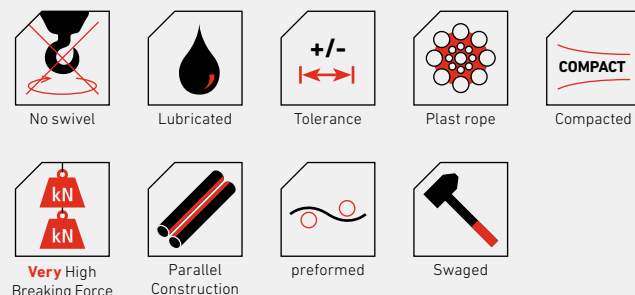
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CASAR PARAFIT

- High performance mining rope
- Swaged 8-strand construction with compacted outer strands
- Double parallel design
- Fully lubricated
- Plastic layer between steel core and outer strands
- Extremely high breaking force
- Good resistance to drum crushing
- Available in ordinary (regular) lay or lang's lay



PROPERTIES

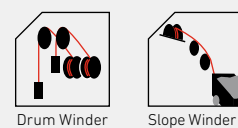


INNOVATIVE DESIGN

APPLICATIONS

High performance hoist rope particularly developed for heavy duty, multi-layer drum winder applications. Our CASAR Parafit MD is cold swaged after manufacture that makes it a very durable rope design with an extremely high breaking force and an excellent flexibility. This innovative rope design provides an increased surface contact area and provides maximum resistance against abrasion and crushing.

Less recommended for koepe friction winder applications.



Nominal Diameter		metallic area		Weight		Aggregate Breaking Force				Minimum Breaking Force			
						1770 N/mm ²		1960 N/mm ²		1770 N/mm ²		1960 N/mm ²	
mm	inch	mm ²	Sqin	kg/m	lb/ft	kN	lbs	kN	lbs	kN	lbs	kN	lbs
20		233.7	0.3622	1.99	1.34	413.6	92,992	458.1	102,974	359.8	80,894	398.5	89,575
21		256.5	0.3976	2.18	1.46	454.0	102,064	502.7	113,020	394.9	88,786	437.5	98,343
22		284.5	0.4410	2.42	1.63	503.6	113,206	557.6	125,358	438.1	98,478	485.2	109,066
	7/8	290.3	0.4500	2.47	1.66	513.9	115,533	569.1	127,935	447.1	100,502	495.1	111,308
23		309.8	0.4802	2.63	1.77	548.3	123,273	607.2	136,506	477.0	107,235	528.3	118,764
24		337.9	0.5237	2.87	1.93	598.1	134,454	662.3	148,887	520.3	116,962	576.1	129,517
25		366.2	0.5676	3.11	2.09	648.2	145,715	717.8	161,357	563.8	126,758	624.4	140,371
	1	378.0	0.5859	3.21	2.16	669.1	150,415	740.9	166,562	582.0	130,846	644.5	144,898
26		393.9	0.6105	3.35	2.25	697.2	156,737	772.0	173,562	606.5	136,346	671.7	151,006
27		426.5	0.6611	3.63	2.44	754.9	169,709	835.9	187,927	656.7	147,630	727.2	163,483
28		459.1	0.7116	3.90	2.62	812.6	182,681	899.8	202,291	706.9	158,914	782.8	175,976
	1 1/8	478.1	0.7411	4.06	2.73	846.3	190,261	937.2	210,685	736.2	165,508	815.3	183,278
29		491.5	0.7618	4.18	2.81	870.0	195,574	963.3	216,567	756.8	170,129	838.0	188,399
30		529.1	0.8201	4.50	3.02	936.5	210,535	1,037.0	233,135	814.7	183,144	902.2	202,832
		565.0	0.8757	4.81	3.23	1,000.0	224,805	1,107.3	248,936	869.9	195,558	963.4	216,579
32	1 1/4	597.5	0.9261	5.08	3.41	1,057.6	237,752	1,171.1	263,274	920.0	206,821	1,018.9	229,065
34		678.7	1.0520	5.77	3.88	1,201.3	270,063	1,330.3	299,052	1,045.0	234,928	1,157.3	260,174
	1 3/8	716.1	1.1100	6.09	4.09	1,267.6	284,957	1,403.6	315,546	1,102.6	247,884	1,221.1	274,523
36		757.5	1.1741	6.44	4.33	1,340.8	301,418	1,484.7	333,774	1,166.3	262,204	1,291.6	290,365
38		848.2	1.3147	7.21	4.85	1,501.3	337,509	1,662.5	373,739	1,306.0	293,599	1,446.4	325,152
	1 1/2	852.7	1.3216	7.25	4.87	1,509.2	339,287	1,671.2	375,708	1,312.9	295,146	1,454.0	326,866
40		934.7	1.4488	7.95	5.34	1,654.4	371,928	1,832.0	411,853	1,439.2	323,540	1,593.8	358,309
	1 5/8	995.2	1.5426	8.46	5.69	1,761.6	396,016	1,950.7	438,527	1,532.4	344,495	1,697.1	381,516
42		1,030.5	1.5973	8.76	5.89	1,824.0	410,048	2,019.8	454,065	1,586.7	356,701	1,757.2	395,032
43		1,080.2	1.6742	9.19	6.17	1,911.9	429,807	2,117.1	475,944	1,663.1	373,889	1,841.9	414,067
44		1,137.6	1.7633	9.68	6.50	2,013.6	452,664	2,229.7	501,256	1,751.6	393,773	1,939.8	436,089
	1 3/4	1,161.0	1.7995	9.87	6.64	2,054.9	461,971	2,275.5	511,561	1,787.6	401,868	1,979.7	445,054
46		1,240.8	1.9232	10.55	7.09	2,196.2	493,729	2,432.0	546,728	1,910.5	429,495	2,115.8	475,642
	1 7/8	1,330.0	2.0615	11.31	7.60	2,354.1	529,228	2,606.8	586,038	2,047.9	460,375	2,267.9	509,840
48		1,351.3	2.0945	11.49	7.72	2,391.8	537,698	2,648.5	595,417	2,080.6	467,744	2,304.2	517,996
50		1,454.6	2.2546	12.37	8.31	2,574.6	578,802	2,851.0	640,934	2,239.7	503,500	2,480.3	557,591
51	2	1,512.0	2.3436	12.86	8.64	2,676.3	601,649	2,963.5	666,232	2,328.1	523,374	2,578.0	579,556
52		1,584.3	2.4557	13.47	9.05	2,804.2	630,409	3,105.2	698,080	2,439.4	548,392	2,701.2	607,259
53		1,645.8	2.5510	13.99	9.40	2,913.1	654,888	3,225.8	725,187	2,534.1	569,687	2,806.1	630,840
54	2 1/8	1,706.9	2.6457	14.51	9.75	3,021.3	679,205	3,345.6	752,114	2,628.2	590,840	2,910.3	654,264
55		1,772.4	2.7472	15.07	10.13	3,137.1	705,246	3,473.8	780,951	2,729.0	613,494	3,021.9	679,349
56		1,837.4	2.8480	15.62	10.50	3,252.2	731,125	3,601.3	809,607	2,829.1	636,005	3,132.8	704,277
57	2 1/4	1,913.6	2.9661	16.27	10.93	3,387.2	761,461	3,750.7	843,200	2,946.5	662,395	3,262.8	733,500
58		1,971.0	3.0550	16.76	11.26	3,488.7	784,281	3,863.1	868,469	3,034.8	682,246	3,360.5	755,481
59		2,039.5	3.1613	17.34	11.65	3,610.0	811,558	3,997.5	898,674	3,140.3	705,974	3,477.4	781,757
60		2,109.3	3.2694	17.94	12.05	3,733.4	839,301	4,134.2	929,396	3,247.7	730,108	3,596.3	808,482
	2 3/8	2,132.2	3.3049	18.13	12.18	3,774.0	848,419	4,179.1	939,492	3,283.0	738,039	3,635.4	817,264
61		2,180.2	3.3792	18.54	12.46	3,858.9	867,511	4,273.1	960,634	3,356.8	754,648	3,717.2	835,656
62		2,252.2	3.4910	19.15	12.87	3,986.4	896,187	4,414.4	992,388	3,467.8	779,593	3,840.1	863,279
63		2,325.5	3.6045	19.77	13.29	4,116.1	925,330	4,557.9	1,024,659	3,580.6	804,944	3,964.9	891,351
	2 1/2	2,362.5	3.6619	20.09	13.50	4,181.7	940,076	4,630.5	1,040,988	3,637.6	817,772	4,028.1	905,555
64		2,399.9	3.7198	20.41	13.71	4,247.8	954,939	4,703.8	1,057,446	3,695.1	830,701	4,091.8	919,872
65		2,475.5	3.8370	21.05	14.14	4,381.6	985,014	4,851.9	1,090,749	3,811.5	856,863	4,220.7	948,843

Product specifications are subject to change without notice or obligation. The shown drawings or cross sections are only for illustrative purposes; the images can vary depending on requested diameter and current status of technical development. This table is for reference only. Additional sizes available upon request.

CASAR DUROPLAST KEEPS THE MINE RUNNING AT A 300% COST SAVING

Time is money. On this basis, the Australian Zinc Mine wanted to optimize production costs. With the help of Casar engineers and a specially developed rope, all expectations were exceeded.

Ropes for hoisting plant systems place special demands on the rope used. Since the introduction of steel cables in mining operations over 150 years ago, the performance and the achievable service life have been continuously improved. But even in our modern times, significant improvements can still be achieved. The basis is a deep understanding of the requirements in the conveyor system, paired with excellent knowledge of special steel wire ropes.

Most Australian mining companies are struggling with high production costs, which can only be offset by trouble-free operation and an overall high production rate. Every interruption due to maintenance, inspection and rope change leads to losses in production and must be reduced to a minimum without endangering the hard-earned safety level in the mine. The performance of the

rope is of particular importance here. The clearly defined goal was therefore to reduce wear and tear and generally to achieve a higher number of bending cycles, of course with the same or even improved safety level.

To meet these edge conditions, the engineers designed a special variant of the well tried and tested Turboplast M product with thicker wires in the outer strands that allow for greater abrasion and an increased level of resistance against radial pressure. Of course, the Duroplast M also has what CASAR specialises in, a coating of the rope core with a special plastic layer. The results speak for themselves. By using the CASAR rope, savings of over 300% were achieved across all costs. The running time of the ropes has increased from 17 months to 59 months and the number of cycles has increased fivefold! An impressive testimony to the performance of the CASAR ropes.

Duroplast M Lifetime:

59 Months

Duroplast M Cycles:

388,000 Cycles

**3.5 TIMES LONGER SERVICE LIFE,
5.5 TIMES HIGHER CYCLES**

**COST SAVING TOTAL:
340% LESS FOR DUROPLAST M
COMPARED TO PREVIOUS ROPE.**

Original Lifetime:

17.0 Months

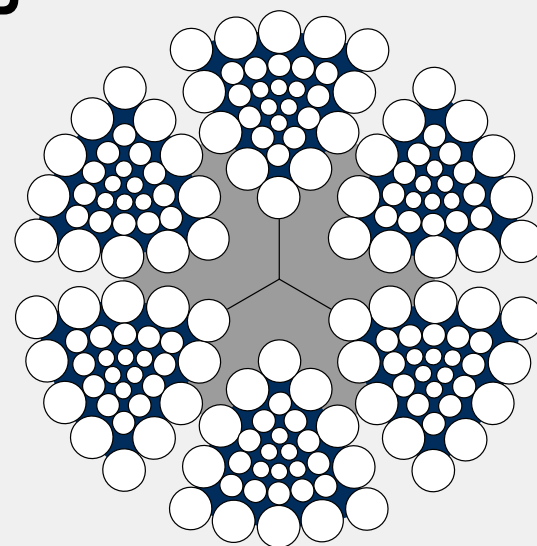
Original Cycles:

70,000 Cycles

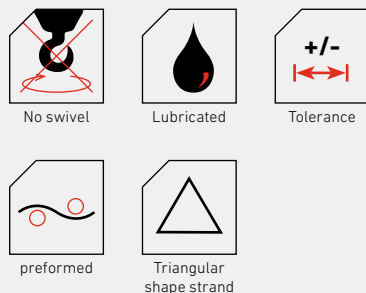


CASAR TRIANGULAR STRAND

- Special mining rope
- 6-strand design with triangular shaped outer strands
- Provides a "flat" surface on sheave and drum areas
- Compact design resists crushing and distortion under heavy loads
- Reduces wear on sheaves and drums
- Available with either fiber core or IWRC
- Fully lubricated



PROPERTIES



APPLICATIONS

Our special triangular (flattened) strand ropes are custom designed and adjusted to diameter and weight requirements and customers' country standards. Tensile strengths are selected to meet certain efficiency or breaking force requirements. Our triangular strand ropes provide a "flat" strand surface on sheave and drum areas, exposing four times more wearing surface than round strand, reducing abrasion and applied unit pressure. The compact design resists crushing and distortion under heavy loads and produces 10 percent greater strength over a standard 6-strand rope. These properties make this product a very proven hoist rope for a wide range of drum and koepe friction winder applications.

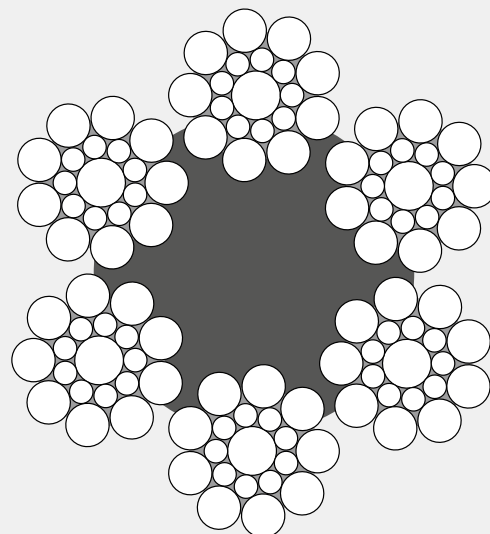


Nominal Diameter		metallic area		Weight		Aggregate Breaking Force				Minimum Breaking Force			
						1770 N/mm ²		1960 N/mm ²		1770 N/mm ²		1960 N/mm ²	
mm	inch	mm ²	Sqin	kg/m	lb/ft	kN	lbs	kN	lbs	kN	lbs	kN	lbs
21		195.0	0.3023	1.77	1.19	345.1	77,582	382.0	85,877	290.0	65,195	321.0	72,164
22		214.0	0.3317	1.94	1.30	378.4	85,068	418.9	94,173	318.0	71,490	352.0	79,133
23		234.0	0.3627	2.13	1.43	412.9	92,824	458.2	103,008	347.0	78,009	385.0	86,552
24		255.0	0.3953	2.32	1.56	449.8	101,120	498.6	112,090	378.0	84,978	419.0	94,195
25		281.0	0.4356	2.53	1.70	487.9	109,685	540.3	121,465	410.0	92,172	454.0	102,064
26		304.0	0.4712	2.74	1.84	549.9	123,623	595.2	133,807	462.1	103,885	500.2	112,450
27		328.0	0.5084	2.95	1.98	600.1	134,908	655.8	147,430	504.3	113,372	551.1	123,893
28		353.0	0.5472	3.17	2.13	643.1	144,575	697.8	156,872	540.4	121,487	586.4	131,829
29		378.0	0.5859	3.43	2.30	695.5	156,355	760.0	170,856	584.5	131,401	638.7	143,586
30		405.0	0.6278	3.63	2.44	732.9	164,763	800.9	180,050	615.9	138,460	673.1	151,320
32		460.0	0.7130	4.14	2.78	837.3	188,233	908.6	204,262	703.6	158,176	763.5	171,642
33		490.0	0.7595	4.38	2.94	890.0	200,081	972.8	218,695	747.9	168,135	817.5	183,782
34		520.0	0.8060	4.68	3.14	946.2	212,715	1,034.1	232,476	795.1	178,746	869.0	195,360
35		551.0	0.8541	4.94	3.32	996.4	224,001	1,088.7	244,751	837.3	188,233	914.8	205,656
36		581.0	0.9006	5.23	3.51	1,046.1	235,174	1,141.1	256,531	879.1	197,630	958.9	215,570
37		616.0	0.9548	5.55	3.73	1,123.3	252,529	1,224.4	275,257	943.9	212,198	1,028.9	231,307
38		649.0	1.0060	5.84	3.92	1,191.3	267,816	1,292.7	290,612	1,001.1	225,057	1,086.3	244,211
39		684.0	1.0602	6.20	4.17	1,255.2	282,182	1,364.9	306,843	1,054.8	237,130	1,147.0	257,857
40		720.0	1.1160	6.40	4.30	1,290.8	290,185	1,390.1	312,508	1,077.8	242,300	1,160.7	260,937
41		756.0	1.1718	6.83	4.59	1,368.5	307,652	1,481.8	333,123	1,142.7	256,890	1,237.3	278,157
42		792.0	1.2276	7.10	4.77	1,432.8	322,108	1,551.5	348,793	1,196.4	268,963	1,295.5	291,241
43		834.0	1.2927	7.48	5.03	1,504.9	338,317	1,629.8	366,395	1,256.6	282,496	1,360.9	305,944
44		871.0	1.3501	7.81	5.25	1,564.1	351,625	1,684.8	378,760	1,306.1	293,624	1,406.8	316,263
45		909.0	1.4090	8.19	5.50	1,627.3	365,833	1,752.8	394,047	1,358.8	305,472	1,463.6	329,032
46		950.0	1.4725	8.53	5.73	1,734.4	389,910	1,871.5	420,732	1,448.2	325,570	1,562.7	351,311
47		992.0	1.5376	8.90	5.98	1,799.5	404,546	1,941.6	436,491	1,502.6	337,800	1,621.3	364,484
48		1,037.0	1.6074	9.30	6.25	1,853.0	416,573	1,995.8	448,676	1,547.3	347,849	1,666.5	374,646
49		1,081.0	1.6756	9.77	6.57	1,932.4	434,423	2,080.6	467,740	1,613.6	362,753	1,737.3	390,562
50		1,125.0	1.7438	10.09	6.78	2,021.7	454,498	2,177.3	489,479	1,688.1	379,502	1,818.0	408,705
51		1,171.0	1.8151	10.49	7.05	2,105.1	473,248	2,267.7	509,802	1,747.0	392,743	1,881.9	423,070
52		1,222.0	1.8941	10.93	7.34	2,184.0	490,985	2,352.2	528,798	1,812.4	407,446	1,952.1	438,852
53		1,267.0	1.9639	11.24	7.55	2,258.4	507,711	2,432.5	546,850	1,874.2	421,339	2,018.7	453,824
54		1,316.0	2.0398	11.72	7.88	2,356.3	529,720	2,533.8	569,624	1,955.5	439,616	2,102.8	472,730
55		1,365.0	2.1158	12.11	8.14	2,429.6	546,198	2,616.6	588,238	2,016.2	453,262	2,171.5	488,175
56		1,415.0	2.1933	12.59	8.46	2,535.4	569,983	2,730.8	613,911	2,104.1	473,023	2,266.2	509,464
57		1,466.0	2.2723	13.05	8.77	2,615.4	587,968	2,817.0	633,290	2,170.4	487,928	2,337.7	525,538
58		1,518.0	2.3529	13.51	9.08	2,725.1	612,630	2,935.4	659,907	2,261.5	508,408	2,436.1	547,660
59		1,571.0	2.4351	13.99	9.40	2,834.0	637,112	3,047.8	685,176	2,351.9	528,731	2,529.3	568,612
60		1,625.0	2.5188	14.43	9.70	2,882.6	648,037	3,105.0	698,035	2,392.2	537,790	2,576.8	579,290

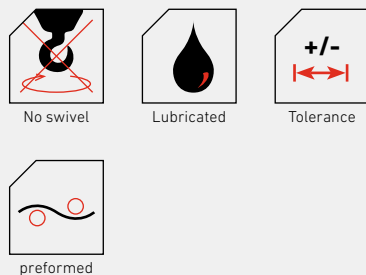
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CASAR 6X19

- Proven and reliable rope construction
- According to EN12385-6
- Available in galvanized and bright
- Available in ordinary (regular) lay or lang's lay
- Available with either fiber core or IWRC
- Fully lubricated

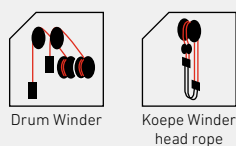


PROPERTIES



APPLICATIONS

The very competitive 6x19 standard rope design is a proven and reliable rope with a wide range of applications.

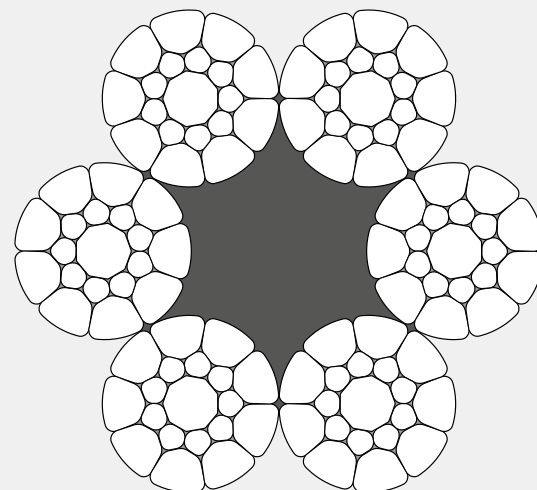


Nominal Diameter		metallic area		Weight		Aggregate Breaking Force				Minimum Breaking Force			
						1770 N/mm ²		1960 N/mm ²		1770 N/mm ²		1960 N/mm ²	
mm	inch	mm ²	Sqin	kg/m	lb/ft	kN	lbs	kN	lbs	kN	lbs	kN	lbs
20		160.0	0.2480	1.47	0.99	283.0	63,621	314.0	70,590	246.0	55,303	273.0	61,373
22		194.0	0.3007	1.78	1.20	343.0	77,110	380.0	85,428	298.0	66,993	330.0	74,187
	7/8	198.0	0.3069	1.81	1.22	350.0	78,684	388.0	87,226	304.0	68,342	337.0	75,761
24		230.0	0.3565	2.10	1.41	407.0	91,498	451.0	101,389	355.0	79,807	393.0	88,350
25		250.0	0.3875	2.30	1.55	443.0	99,591	490.0	110,157	385.0	86,551	426.0	95,769
	1	258.0	0.3999	2.40	1.61	457.0	102,738	506.0	113,754	397.0	89,249	440.0	98,916
26		270.0	0.4185	2.50	1.68	478.0	107,459	529.0	118,924	416.0	93,521	461.0	103,637
28		314.0	0.4867	2.90	1.95	556.0	124,994	615.0	138,258	483.0	108,583	535.0	120,273
	1 1/8	327.0	0.5069	3.00	2.02	579.0	130,165	641.0	144,103	503.0	113,079	557.0	125,219
30		360.0	0.5580	3.30	2.22	637.0	143,204	706.0	158,716	554.0	124,544	614.0	138,033
	1 1/4	403.0	0.6247	3.70	2.49	713.0	160,290	790.0	177,600	621.0	139,606	688.0	154,669
32		410.0	0.6355	3.80	2.55	726.0	163,212	804.0	180,747	631.0	141,854	698.0	156,917
34		462.0	0.7161	4.20	2.82	818.0	183,895	906.0	203,678	712.0	160,064	788.0	177,149
	1 3/8	488.0	0.7564	4.50	3.02	864.0	194,236	956.0	214,918	752.0	169,056	832.0	187,041
36		518.0	0.8029	4.80	3.23	917.0	206,151	1,015.0	228,182	798.0	179,398	884.0	198,731
38	1 1/2	578.0	0.8959	5.30	3.56	1,023.0	229,981	1,133.0	254,710	889.0	199,855	985.0	221,437
40		640.0	0.9920	5.90	3.96	1,133.0	254,710	1,254.0	281,912	986.0	221,662	1,090.0	245,042
	1 5/8	682.0	1.0571	6.30	4.23	1,207.0	271,346	1,337.0	300,571	1,050.0	236,049	1,160.0	260,778
42		706.0	1.0943	6.50	4.37	1,250.0	281,013	1,384.0	311,137	1,090.0	245,042	1,200.0	269,771
44		774.0	1.1997	7.10	4.77	1,370.0	307,990	1,517.0	341,037	1,190.0	267,523	1,320.0	296,748
	1 3/4	790.0	1.2245	7.30	4.91	1,398.0	314,284	1,548.0	348,006	1,220.0	274,267	1,350.0	303,492
46		846.0	1.3113	7.80	5.24	1,497.0	336,541	1,658.0	372,735	1,300.0	292,252	1,440.0	323,725

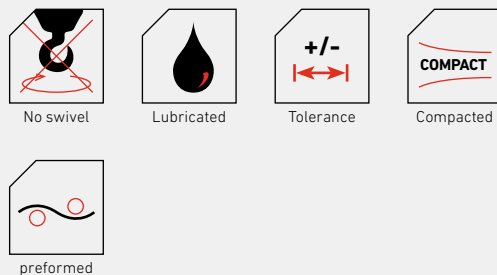
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CASAR 6X19 COMPACTED

- Proven and reliable rope construction
- According to EN12385-6
- Available in galvanized and bright
- Available in ordinary (regular) lay or lang's lay
- Available with either fiber core or IWRC
- Fully lubricated

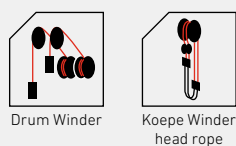


PROPERTIES



APPLICATIONS

The compacted 6x19 standard rope design is a proven and reliable rope with a wide range of applications.

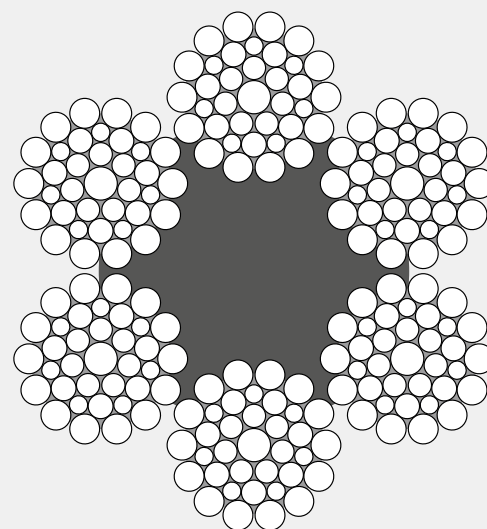


Nominal Diameter		metallic area		Weight		Aggregate Breaking Force				Minimum Breaking Force			
						1770 N/mm ²		1960 N/mm ²		1770 N/mm ²		1960 N/mm ²	
mm	inch	mm ²	Sqin	kg/m	lb/ft	kN	lbs	kN	lbs	kN	lbs	kN	lbs
20		181.0	0.2806	1.70	1.14	320.0	71,939	355.0	79,807	264.0	59,350	292.0	65,644
22		219.0	0.3395	2.10	1.41	388.0	87,226	429.0	96,443	320.0	71,939	354.0	79,582
	7/8	224.0	0.3472	2.10	1.41	396.0	89,024	439.0	98,691	326.0	73,288	361.0	81,156
24		261.0	0.4046	2.40	1.61	462.0	103,862	512.0	115,102	380.0	85,427	421.0	94,645
25		283.0	0.4387	2.70	1.81	501.0	112,629	555.0	124,769	413.0	92,846	457.0	102,738
	1	292.0	0.4526	2.70	1.81	517.0	116,226	572.0	128,591	426.0	95,769	472.0	106,110
26		306.0	0.4743	2.90	1.95	542.0	121,846	600.0	134,885	446.0	100,265	494.0	111,056
28		355.0	0.5503	3.30	2.22	628.0	141,180	696.0	156,467	518.0	116,451	573.0	128,815
	1 1/8	370.0	0.5735	3.50	2.35	655.0	147,250	725.0	162,986	539.0	121,172	597.0	134,211
30		408.0	0.6324	3.80	2.55	722.0	162,312	800.0	179,847	594.0	133,536	658.0	147,924
	1 1/4	457.0	0.7084	4.30	2.89	809.0	181,870	896.0	201,429	666.0	149,723	737.0	165,684
32		464.0	0.7192	4.40	2.96	821.0	184,568	909.0	204,351	676.0	151,971	749.0	168,382
34		524.0	0.8122	4.90	3.29	927.0	208,398	1,027.0	230,879	763.0	171,529	845.0	189,964
	1 3/8	553.0	0.8572	5.20	3.49	979.0	220,088	1,084.0	243,693	806.0	181,196	892.0	200,530
36		587.0	0.9099	5.50	3.70	1,039.0	233,576	1,151.0	258,755	856.0	192,436	947.0	212,894
38	1 1/2	654.0	1.0137	6.10	4.10	1,158.0	260,329	1,282.0	288,205	953.0	214,243	1,060.0	238,297
40		725.0	1.1238	6.80	4.57	1,283.0	288,430	1,421.0	319,453	1,060.0	238,297	1,170.0	263,026
	1 5/8	772.0	1.1966	7.20	4.84	1,366.0	307,089	1,513.0	340,136	1,130.0	254,034	1,250.0	281,011
42		799.0	1.2385	7.50	5.04	1,414.0	317,880	1,566.0	352,051	1,160.0	260,778	1,290.0	290,003
44		877.0	1.3594	8.20	5.51	1,552.0	348,903	1,719.0	386,446	1,280.0	287,755	1,420.0	319,229

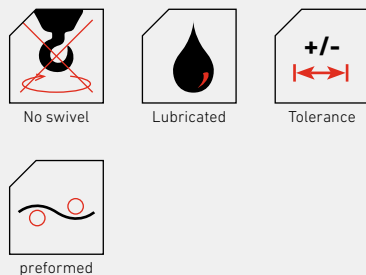
Product specifications are subject to change without notice or obligation. The shown drawings or cross sections are only for illustrative purposes; the images can vary depending on requested diameter and current status of technical development. This table is for reference only. Additional sizes available upon request.

CASAR 6X36

- Proven and reliable rope construction
- According to EN12385-6
- Available in galvanized and bright
- Available in ordinary (regular) lay or lang's lay
- Available with either fiber core or IWRC
- Fully lubricated

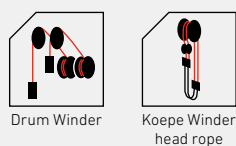


PROPERTIES



APPLICATIONS

The very competitive 6x36 standard rope design is a proven and reliable rope with a wide range of applications.

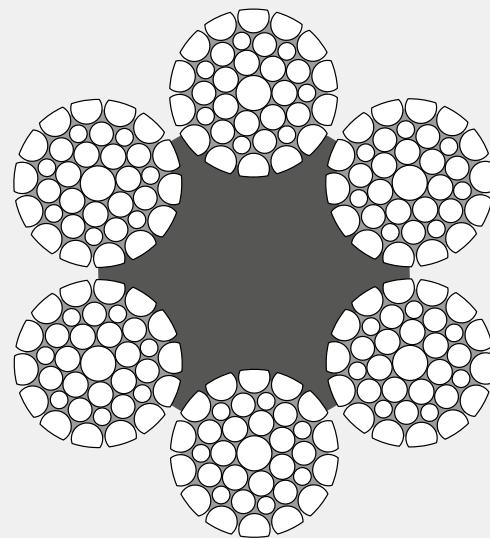


Nominal Diameter	metallic area		Weight		Aggregate Breaking Force				Minimum Breaking Force				
					1770 N/mm ²		1960 N/mm ²		1770 N/mm ²		1960 N/mm ²		
mm	inch	mm ²	Sqin	kg/m	lb/ft	kN	lbs	kN	lbs	kN	lbs	kN	lbs
20		162.0	0.2511	1.51	1.01	287.0	64,520	318.0	71,489	244.0	54,853	270.0	60,698
22		196.0	0.3038	1.83	1.23	347.0	78,009	384.0	86,327	295.0	66,319	326.0	73,288
	7/8	200.0	0.3100	1.87	1.26	354.0	79,582	392.0	88,125	301.0	67,667	333.0	74,861
24		233.0	0.3612	2.20	1.48	412.0	92,621	457.0	102,738	351.0	78,908	388.0	87,226
25		253.0	0.3922	2.40	1.61	448.0	100,714	496.0	111,505	381.0	85,652	421.0	94,645
	1	261.0	0.4046	2.40	1.61	462.0	103,862	512.0	115,102	393.0	88,350	435.0	97,792
26		274.0	0.4247	2.60	1.75	485.0	109,032	537.0	120,722	412.0	92,621	456.0	102,513
28		318.0	0.4929	3.00	2.02	563.0	126,567	623.0	140,056	477.0	107,234	529.0	118,924
	1 1/8	331.0	0.5131	3.10	2.08	586.0	131,738	649.0	145,901	497.0	111,730	551.0	123,870
30		365.0	0.5658	3.40	2.28	646.0	145,227	715.0	160,738	548.0	123,195	607.0	136,459
	1 1/4	408.0	0.6324	3.80	2.55	722.0	162,312	800.0	179,847	614.0	138,033	680.0	152,870
32		415.0	0.6433	3.90	2.62	735.0	165,235	813.0	182,770	623.0	140,056	690.0	155,118
34		468.0	0.7254	4.40	2.96	828.0	186,142	917.0	206,150	704.0	158,265	779.0	175,126
	1 3/8	494.0	0.7657	4.60	3.09	874.0	196,483	968.0	217,615	743.0	167,033	823.0	185,018
36		525.0	0.8138	4.90	3.29	929.0	208,847	1,029.0	231,328	789.0	177,374	874.0	196,483
38		585.0	0.9068	5.40	3.63	1,035.0	232,677	1,147.0	257,856	879.0	197,607	974.0	218,964
40		648.0	1.0044	6.00	4.03	1,147.0	257,856	1,270.0	285,507	974.0	218,964	1,080.0	242,794
	1 5/8	690.0	1.0695	6.40	4.30	1,221.0	274,492	1,352.0	303,942	1,040.0	233,801	1,150.0	258,530
42		714.0	1.1067	6.70	4.50	1,264.0	284,158	1,399.0	314,508	1,070.0	240,546	1,190.0	267,523
44		784.0	1.2152	7.30	4.91	1,388.0	312,035	1,537.0	345,531	1,180.0	265,275	1,310.0	294,500
	1 3/4	800.0	1.2400	7.50	5.04	1,416.0	318,329	1,568.0	352,500	1,200.0	269,771	1,330.0	298,996
46		857.0	1.3284	8.00	5.38	1,517.0	341,035	1,680.0	377,679	1,290.0	290,003	1,430.0	321,477
	1 7/8	919.0	1.4245	8.60	5.78	1,627.0	365,764	1,801.0	404,881	1,380.0	310,236	1,530.0	343,958
48		933.0	1.4462	8.70	5.85	1,651.0	371,159	1,829.0	411,175	1,400.0	314,732	1,550.0	348,454
50		1,013.0	1.5702	9.40	6.32	1,793.0	403,082	1,985.0	446,246	1,520.0	341,710	1,690.0	379,927
	2	1,045.0	1.6198	9.70	6.52	1,850.0	415,896	2,048.0	460,409	1,570.0	352,950	1,740.0	391,167
52		1,095.0	1.6973	10.20	6.85	1,938.0	435,680	2,146.0	482,440	1,650.0	370,935	1,820.0	409,152
54		1,181.0	1.8306	11.00	7.39	2,090.0	469,851	2,315.0	520,433	1,780.0	400,160	1,970.0	442,874
56		1,270.0	1.9685	11.80	7.93	2,248.0	505,370	2,489.0	559,549	1,910.0	429,385	2,110.0	474,347
	2 1/4	1,323.0	2.0507	12.30	8.27	2,342.0	526,502	2,593.0	582,929	1,990.0	447,370	2,200.0	494,580
58		1,362.0	2.1111	12.70	8.53	2,411.0	542,014	2,670.0	600,240	2,050.0	460,858	2,270.0	510,316
60		1,458.0	2.2599	13.60	9.14	2,581.0	580,232	2,858.0	642,504	2,190.0	492,331	2,430.0	546,286
	2 3/8	1,474.0	2.2847	13.70	9.21	2,609.0	586,526	2,889.0	649,473	2,540.0	571,015	2,540.0	571,015
62		1,557.0	2.4134	14.50	9.74	2,756.0	619,573	3,052.0	686,117	2,660.0	597,992	2,660.0	597,992
	2 1/2	1,633.0	2.5312	15.20	10.21	2,890.0	649,698	3,201.0	719,613	2,770.0	622,721	2,770.0	622,721
64		1,659.0	2.5715	15.50	10.42	2,936.0	660,039	3,252.0	731,079	2,810.0	631,713	2,810.0	631,713

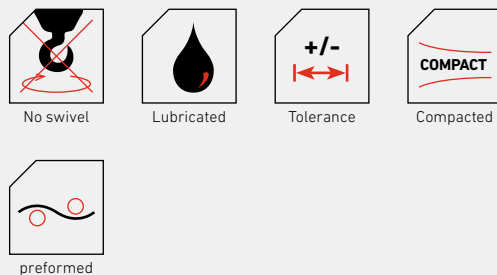
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CASAR 6X36 COMPACTED

- Proven and reliable rope construction
- According to EN12385-6
- Available in galvanized and bright
- Available in ordinary (regular) lay or lang's lay
- Available with either fiber core or IWRC
- Fully lubricated

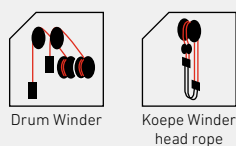


PROPERTIES



APPLICATIONS

The compacted 6x36 standard rope design is a proven and reliable rope with a wide range of applications.



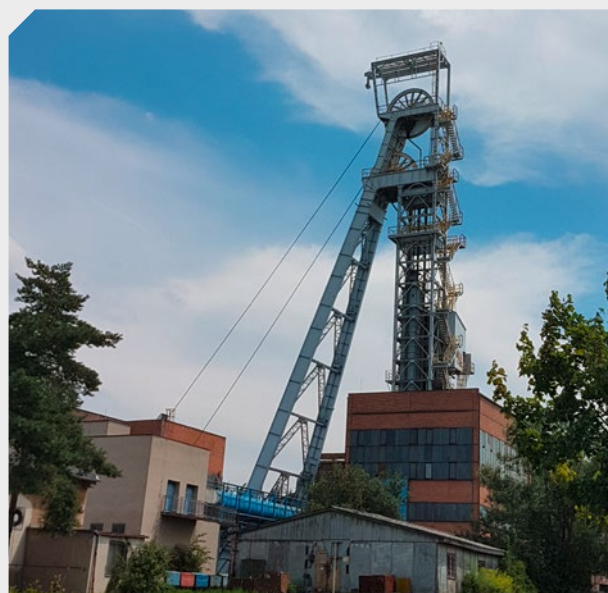
Nominal Diameter	metallic area		Weight		Aggregate Breaking Force				Minimum Breaking Force				
					1770 N/mm ²		1960 N/mm ²		1770 N/mm ²		1960 N/mm ²		
mm	inch	mm ²	Sqin	kg/m	lb/ft	kN	lbs	kN	lbs	kN	lbs	kN	lbs
20		181.0	0.2806	1.70	1.14	320.0	71,939	355.0	79,807	264.0	59,350	292.0	65,644
22		219.0	0.3395	2.10	1.41	388.0	87,226	429.0	96,443	320.0	71,939	354.0	79,582
	7/8	224.0	0.3472	2.10	1.41	396.0	89,024	439.0	98,691	326.0	73,288	361.0	81,156
24		261.0	0.4046	2.40	1.61	462.0	103,862	512.0	115,102	380.0	85,427	421.0	94,645
25		283.0	0.4387	2.70	1.81	501.0	112,629	555.0	124,769	413.0	92,846	457.0	102,738
	1	292.0	0.4526	2.70	1.81	517.0	116,226	572.0	128,591	426.0	95,769	472.0	106,110
26		306.0	0.4743	2.90	1.95	542.0	121,846	600.0	134,885	446.0	100,265	494.0	111,056
28		355.0	0.5503	3.30	2.22	628.0	141,180	696.0	156,467	518.0	116,451	573.0	128,815
	1 1/8	370.0	0.5735	3.50	2.35	655.0	147,250	725.0	162,986	539.0	121,172	597.0	134,211
30		408.0	0.6324	3.80	2.55	722.0	162,312	800.0	179,847	594.0	133,536	658.0	147,924
	1 1/4	457.0	0.7084	4.30	2.89	809.0	181,870	896.0	201,429	666.0	149,723	737.0	165,684
32		464.0	0.7192	4.40	2.96	821.0	184,568	909.0	204,351	676.0	151,971	749.0	168,382
34		524.0	0.8122	4.90	3.29	927.0	208,398	1,027.0	230,879	763.0	171,529	845.0	189,964
	1 3/8	553.0	0.8572	5.20	3.49	979.0	220,088	1,084.0	243,693	806.0	181,196	892.0	200,530
36		587.0	0.9099	5.50	3.70	1,039.0	233,576	1,151.0	258,755	856.0	192,436	947.0	212,894
38		654.0	1.0137	6.10	4.10	1,158.0	260,329	1,282.0	288,205	953.0	214,243	1,060.0	238,297
40		725.0	1.1238	6.80	4.57	1,283.0	288,430	1,421.0	319,453	1,060.0	238,297	1,170.0	263,026
	1 5/8	772.0	1.1966	7.20	4.84	1,366.0	307,089	1,513.0	340,136	1,130.0	254,034	1,250.0	281,011
42		799.0	1.2385	7.50	5.04	1,414.0	317,880	1,566.0	352,051	1,160.0	260,778	1,290.0	290,003
44		877.0	1.3594	8.20	5.51	1,552.0	348,903	1,719.0	386,446	1,280.0	287,755	1,420.0	319,229
	1 3/4	895.0	1.3873	8.40	5.64	1,584.0	356,097	1,754.0	394,315	1,300.0	292,252	1,440.0	323,725
46		959.0	1.4865	9.00	6.05	1,697.0	381,501	1,880.0	422,641	1,400.0	314,732	1,550.0	348,454
	1 7/8	1028.0	1.5934	9.60	6.45	1,820.0	409,152	2,015.0	452,990	1,500.0	337,213	1,660.0	373,183
48		1044.0	1.6182	9.80	6.59	1,848.0	415,447	2,046.0	459,959	1,520.0	341,710	1,680.0	377,679
50		1133.0	1.7562	10.60	7.12	2,005.0	450,742	2,221.0	499,301	1,650.0	370,935	1,830.0	411,400
	2	1169.0	1.8120	11.00	7.39	2,069.0	465,130	2,291.0	515,037	1,700.0	382,175	1,890.0	424,889
52		1225.0	1.8988	11.50	7.73	2,168.0	487,386	2,401.0	539,766	1,790.0	402,408	1,980.0	445,122
54		1321.0	2.0476	12.40	8.33	2,338.0	525,603	2,589.0	582,030	1,930.0	433,881	2,130.0	478,843
56		1421.0	2.2026	13.30	8.94	2,515.0	565,394	2,785.0	626,093	2,070.0	465,354	2,290.0	514,812
	2 1/4	1480.0	2.2940	13.90	9.34	2,620.0	588,999	2,901.0	652,171	2,160.0	485,587	2,390.0	537,293
58		1524.0	2.3622	14.30	9.61	2,697.0	606,310	2,987.0	671,504	2,220.0	499,076	2,460.0	553,030
60		1631.0	2.5281	15.30	10.28	2,887.0	649,023	3,197.0	718,714	2,380.0	535,045	2,630.0	591,247

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NEW RECORD ON CASAR MINING ROPES IN SLOVAKIA

Productivity is key for mining operations and reliable and performing hoist ropes play a most important role in this. A mine in Slovakia has succeeded in breaking records.

In the Slovakian mining region of Horna Nitra, the company HBP, operates a total of 3 pits near the city of Prievidza. With an annual output of 1.9 million tons and over 100 years' experience, HBP is the largest brown coal producer in Slovakia.



The mine succeeded in achieving a cycle count of 656,000 and a total output of 12 million ton of moved rocks on the floor-based friction winch. On that mine there are 2 shafts, the North Shaft with a drum winch and a Ø40mm Turboplast M, and the South Shaft with the Ø66mm Turboplast M on a friction winch. The record-breaking rope is the Ø66mm Turboplast M with an operating length of 570m. The friction winch here reaches speeds of 12m/s and a load capacity of 7t. The installed rope has a lifetime of over 10 years with rope still on the system and will therefore push the record even higher. The mine has kept detailed records on the lifetimes of all ropes installed since 1976. The current rope is the thirteenth so far, and it has exceeded the lifetimes of all its predecessors by a factor of at least 2. Its safety is guaranteed through a magneto-inductive test, which takes place every six months. It is expected that the rope will remain on the system for some time yet – an even higher bar for future records! This is all the more remarkable because the rope has never been lubricated since its installation. The shaft is a dry shaft, however.

2 TIMES LONGER SERVICE LIFE, STILL PUSHING EVEN FURTHER

Predecessors Lifetimes:
max. 5 years

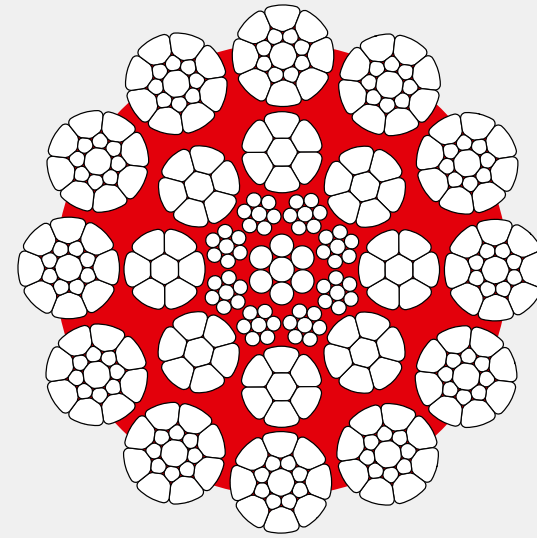
Turboplast M Tonnage:
12 Mill. Tons
Turboplast M Cycles:
656,000 Cycles

↑
still rising, setting the bar for future records even higher



CASAR DOUZEPLAST VM

- High performance mining rope
- Koepe Tail / Balance Rope
- Designed to have a specific unit weight
- Rotation resistant
- Fully lubricated
- Plastic layer between steel core and outer strands
- Available in ordinary (regular) lay or lang's lay
- Available with conventional or with compacted strands

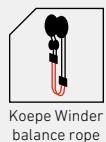


PROPERTIES

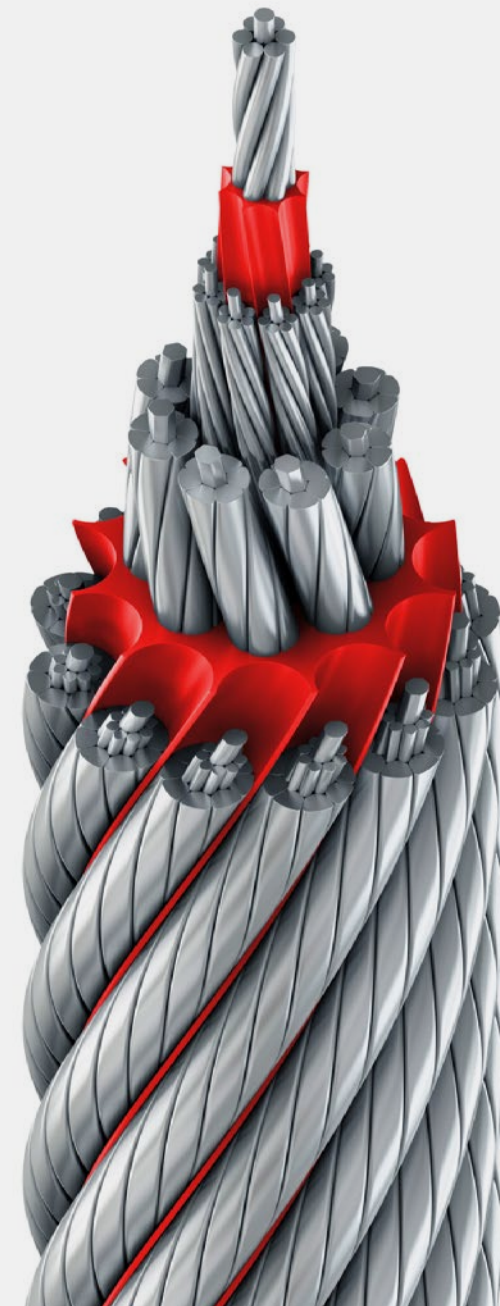


APPLICATIONS

High performance balance (tail) rope for koepe friction winder applications, where rotation-resistant ropes are required. Rope design and manufacturing parameters are adjusted according to the application, i.e. Douzeplast MT and Douzeplast VMT. The Douzeplast VM is a very flexible rope design, providing an excellent resistance to fatigue and corrosion.



Koepe Winder balance rope



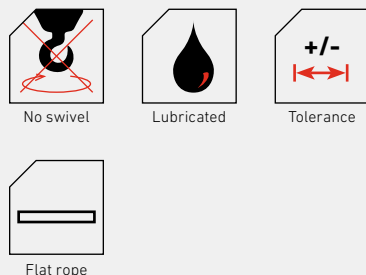
Nominal Diameter		metallic area		Weight		Aggregate Breaking Force				Minimum Breaking Force			
						1770 N/mm ²		1960 N/mm ²		1770 N/mm ²		1960 N/mm ²	
mm	inch	mm ²	Sqin	kg/m	lb/ft	kN	lbs	kN	lbs	kN	lbs	kN	lbs
20		206.7	0.3204	1.81	1.22	324.5	72,955	365.9	82,248	276.2	62,085	303.7	68,274
21		222.4	0.3447	1.95	1.31	349.1	78,483	393.6	88,481	297.1	66,789	334.8	75,266
22		244.0	0.3783	2.14	1.44	383.2	86,136	432.0	97,108	326.1	73,302	367.5	82,617
	7/8	249.1	0.3860	2.18	1.47	391.0	87,907	440.8	99,105	332.8	74,809	375.1	84,316
23		266.7	0.4134	2.34	1.57	418.8	94,144	472.1	106,137	356.4	80,117	401.6	90,283
24		290.4	0.4502	2.55	1.71	456.0	102,509	514.1	115,567	388.0	87,235	437.3	98,309
25		315.1	0.4885	2.76	1.86	494.8	111,229	557.8	125,398	421.1	94,656	474.5	106,672
	1	325.3	0.5042	2.85	1.92	510.7	114,817	575.8	129,443	434.6	97,709	489.8	110,113
26		340.9	0.5283	2.99	2.01	535.1	120,305	603.3	135,631	455.4	102,380	513.2	115,372
27		367.6	0.5697	3.22	2.17	577.1	129,738	650.6	146,265	491.1	110,407	553.5	124,432
28		395.3	0.6127	3.47	2.33	620.6	139,526	699.7	157,300	528.2	118,736	595.2	133,806
	1 1/8	411.7	0.6382	3.61	2.43	646.4	145,315	728.7	163,827	550.1	123,663	619.9	139,358
29		424.1	0.6573	3.72	2.50	665.8	149,670	750.6	168,736	566.6	127,369	638.5	143,540
30		453.8	0.7034	3.98	2.67	712.5	160,170	803.2	180,574	606.3	136,304	683.3	153,612
31		484.6	0.7511	4.25	2.86	760.8	171,026	857.7	192,812	647.4	145,543	729.6	164,021
	1 1/4	508.3	0.7879	4.46	3.00	798.0	179,401	899.7	202,255	679.1	152,670	765.3	172,053
32		516.3	0.8003	4.53	3.04	810.6	182,238	913.9	205,453	689.8	155,084	777.4	174,766
33		549.1	0.8511	4.82	3.24	862.1	193,805	971.9	218,494	733.6	164,928	826.8	185,872
34		582.9	0.9035	5.11	3.44	915.1	205,729	1,031.7	231,937	778.8	175,076	877.7	197,315
35	1 3/8	615.0	0.9533	5.39	3.62	965.6	217,076	1,088.6	244,728	821.7	184,731	930.0	209,072
36		653.5	1.0129	5.73	3.85	1,026.0	230,644	1,156.7	260,026	873.1	196,278	983.9	221,189
37		690.3	1.0699	6.05	4.07	1,083.7	243,636	1,221.8	274,672	922.3	207,334	1,039.4	233,666
38	1 1/2	731.9	1.1345	6.42	4.31	1,149.1	258,338	1,295.5	291,247	977.9	219,845	1,096.3	246,458
39		766.9	1.1887	6.73	4.52	1,204.1	270,687	1,357.5	305,169	1,024.7	230,355	1,154.8	259,609
40		806.8	1.2505	7.08	4.75	1,266.6	284,746	1,428.0	321,020	1,077.9	242,319	1,214.8	273,098
41		847.6	1.3138	7.43	5.00	1,330.7	299,162	1,500.3	337,271	1,132.5	254,586	1,276.2	286,901
	1 5/8	859.0	1.3315	7.53	5.06	1,348.6	303,188	1,520.5	341,811	1,147.7	258,013	1,293.4	290,763
42		889.5	1.3787	7.80	5.24	1,396.4	313,933	1,574.3	353,924	1,188.4	267,157	1,371.0	308,213
43		932.3	1.4451	8.18	5.49	1,463.7	329,060	1,650.2	370,978	1,245.6	280,030	1,403.8	315,587
44		976.2	1.5131	8.56	5.75	1,532.6	344,543	1,727.8	388,434	1,304.2	293,206	1,469.8	330,424
	1 3/4	996.3	1.5442	8.74	5.87	1,564.1	351,626	1,763.4	396,420	1,331.1	299,234	1,500.0	337,217
45		1,021.1	1.5826	8.95	6.02	1,603.1	360,382	1,807.3	406,291	1,364.2	306,685	1,537.4	345,621
46		1,066.9	1.6538	9.36	6.29	1,675.1	376,577	1,888.5	424,549	1,425.5	320,467	1,606.5	361,155
	1 7/8	1,143.7	1.7727	10.03	6.74	1,795.5	403,653	2,024.3	455,074	1,528.0	343,509	1,722.0	387,123
47		1,113.8	1.7264	9.77	6.56	1,748.7	393,128	1,971.5	443,208	1,488.2	334,552	1,677.1	377,027
48		1,161.7	1.8007	10.19	6.85	1,823.9	410,035	2,056.3	462,268	1,552.2	348,939	1,749.2	393,236
49		1,210.6	1.8765	10.62	7.13	1,900.7	427,297	2,142.8	481,730	1,617.5	363,630	1,822.9	409,804
50		1,260.6	1.9539	11.06	7.43	1,979.1	444,916	2,231.2	501,593	1,684.2	378,624	1,898.0	426,687
	2	1,301.2	2.0169	11.41	7.67	2,042.9	459,267	2,303.2	517,773	1,738.5	390,836	1,959.2	440,451
51		1,311.5	2.0328	11.50	7.73	2,059.0	462,891	2,321.3	521,858	1,752.2	393,920	1,974.7	443,930
52		1,363.4	2.1133	11.96	8.03	2,140.6	481,221	2,413.3	542,523	1,821.6	409,519	2,052.9	461,510
53		1,416.4	2.1954	12.42	8.35	2,223.7	499,908	2,507.0	563,590	1,892.4	425,421	2,132.6	479,427
54	2 1/8	1,469.0	2.2769	12.88	8.66	2,306.3	518,470	2,600.1	584,517	1,962.6	441,218	2,213.9	497,704
55		1,525.3	2.3642	13.38	8.99	2,394.7	538,348	2,699.8	606,928	2,037.9	458,135	2,296.6	516,296
56		1,581.3	2.4509	13.87	9.32	2,482.6	558,103	2,798.8	629,199	2,112.7	474,945	2,380.9	535,248
57		1,638.2	2.5393	14.37	9.65	2,572.0	578,213	2,899.7	651,871	2,188.8	492,059	2,466.7	554,536
	2 1/4	1,646.9	2.5526	14.44	9.71	2,585.6	581,260	2,914.9	655,306	2,200.3	494,652	2,479.7	557,459
58		1,696.2	2.6291	14.88	10.00	2,663.1	598,679	3,002.3	674,944	2,266.3	509,476	2,554.0	574,162
59		1,755.2	2.7206	15.39	10.34	2,755.7	619,501	3,106.7	698,418	2,345.1	527,195	2,642.8	594,125
60		1,815.2	2.8136	15.92	10.70	2,849.9	640,679	3,212.9	722,294	2,425.3	545,218	2,733.2	614,448
	2 3/8	1,834.9	2.8441	16.09	10.81	2,880.8	647,639	3,247.8	730,140	2,451.6	551,140	2,762.9	621,122
61		1,876.2	2.9081	16.45	11.06	2,945.7	662,213	3,320.9	746,571	2,506.8	563,543	2,825.1	635,108
62		1,938.2	3.0043	17.00	11.42	3,043.0	684,103	3,430.7	771,250	2,589.6	582,172	2,918.4	656,082
63		2,001.3	3.1020	17.55	11.79	3,142.0	706,349	3,542.3	796,329	2,673.8	601,103	3,013.3	677,417
	2 1/2	2,033.2	3.1514	17.83	11.98	3,192.1	717,605	3,598.7	809,020	2,716.4	610,682	3,061.3	688,212
64		2,065.3	3.2012	18.11	12.17	3,242.5	728,950	3,655.6	821,810	2,759.4	620,337	3,109.8	699,111
65		2,130.4	3.3020	18.68	12.55	3,344.7	751,908	3,770.7	847,693	2,846.3	639,874	3,207.7	721,120

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CASAR FLAT BALANCE ROPE

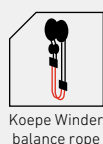
- Koepe Tail / Balance Rope
- Conventional strands
- Designed to have a specific unit weight
- Very flexible
- Very small loop diameter
- Single or double stitched
- Riveted
- Conforms to EN12385-6

PROPERTIES

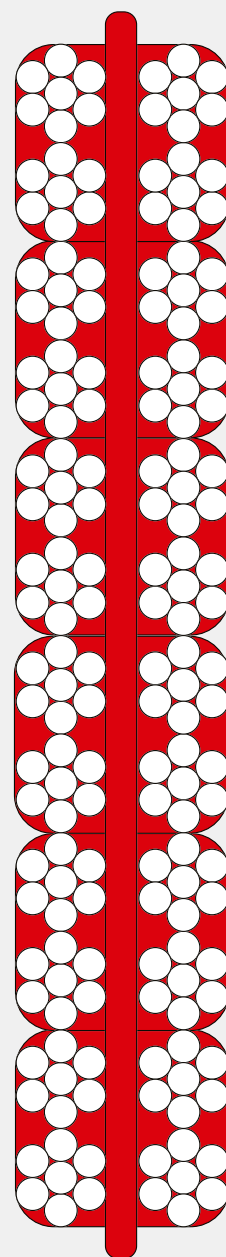


APPLICATIONS

Our proven and reliable flat rope is perfectly designed to operate as a balance (tail) rope on a koepe friction winder application. It is made according to the EN12385 standard at the most modern manufacturing line worldwide. Due to its flat shape, very small balance rope loop diameters are possible to fit into small shaft compartments.



Koepe Winder balance rope

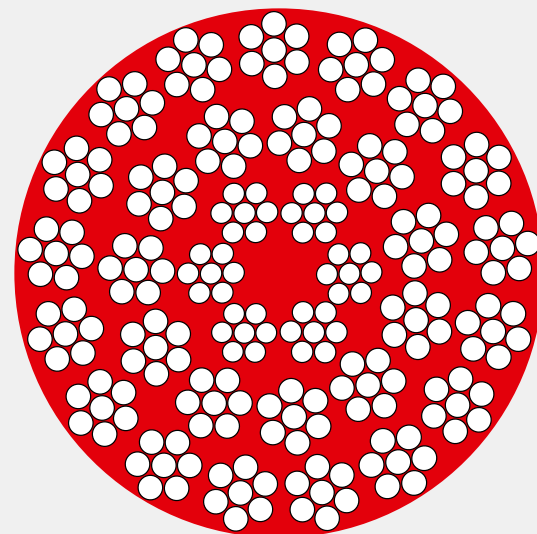


Nominal values width w x thickness s mm		Nominal diameter of load-bearing wires	Sum of nominal cross sectional area of load-bearing wires	Nominal rope length mass of lubricated rope			Minimum Aggregate Breaking Force $f_{e,min}$	
double stitched	single stitched or riveted			double stitched	single stitched	riveted/ clamped	Rope Grade	
mm	mm	mm	mm ²	kg/100 m	kg/100 m	kg/100 m	1370	1570
							kN	kN
Rope class: 6 x 4 x 7 = 6 unit ropes each of 4 strands each of 1+6 wires = 168 wires								
70x17	70x15	1.6	338	342	328	322	463	531
74x18	74x16	1.7	381	385	370	362	522	598
78x19	78x17	1.8	428	433	416	407	586	672
82x20	82x18	1.9	476	481	462	453	652	747
87x21	87x19	2.0	526	534	513	502	723	829
91x22	91x20	2.1	582	588	565	553	797	914
95x23	95x21	2.2	639	646	620	607	875	1003
Rope class: 8 x 4 x 7 = 8 unit ropes each of 4 strands each of 1+6 wires = 224 wires								
110x20	110x18	1.9	635	642	616	604	870	997
113x20	113x18	1.95	669	676	649	636	917	1050
116x21	116x19	2.0	704	711	683	669	964	1105
119x21	119x19	2.05	739	747	717	702	1010	1160
122x22	122x20	2.1	776	784	753	738	1060	1220
125x22	125x20	2.15	813	822	789	773	1110	1280
128x23	128x21	2.2	851	860	826	809	1170	1340
Rope class: 6 x 4 x 12 = 6 unit ropes each of 4 strands each of 3+9 wires = 288 wires								
112x26	112x23	1.9	817	826	793	768	1120	1280
115x26	115x23	1.95	860	869	835	809	1180	1350
118x27	118x24	2.0	905	914	878	851	1240	1420
121x27	121x24	2.05	951	961	923	894	1300	1490
124x28	124x25	2.1	998	1010	968	939	1370	1570
127x28	127x25	2.15	1046	1060	1020	984	1430	1640
130x29	130x26	2.2	1095	1110	1070	1030	1500	1720
Rope class: 8 x 4 x 12 M= 8 unit ropes each of 4 strands each of 3+9 wires = 384 wires								
146x25	146x23	1.9	1089	1100	1060	1030	1490	1710
149x26	149x23	1.95	1147	1160	1120	1080	1570	1800
154x27	154x24	2.0	1206	1220	1170	1140	1650	1890
157x27	157x24	2.05	1267	1280	1230	1190	1740	1990
160x28	160x25	2.1	1330	1350	1290	1250	1820	2090
165x28	165x25	2.15	1394	1410	1360	1310	1910	2190
168x29	168x26	2.2	1460	1480	1420	1380	2000	2290
Rope class: 8 x 4 x 14 M= 8 unit ropes each of 4 strands each of 4+10 wires = 448 wires								
168x28	168x25	2.0	1407	1430	1370	1330	1930	2210
172x29	172x26	2.05	1479	1500	1440	1390	2030	2320
176x29	176x26	2.1	1552	1570	1510	1460	2130	2440
180x30	180x27	2.15	1626	1650	1580	1530	2230	2550
184x30	184x27	2.2	1703	1720	1660	1600	2330	2670
Rope class: 8 x 4 x 19 M= 8 unit ropes each of 4 strands each of 1+6+12 wires = 608 wires								
186x31	186x28	1.9	1724	1750	1680	1620	2360	2710
190x32	190x29	1.95	1816	1840	1780	1700	2490	2850
194x33	194x30	2.0	1910	1930	1860	1800	2620	3000
200x34	200x31	2.05	2007	2030	1950	1890	2750	3150
204x34	204x31	2.1	2106	2130	2040	1980	2890	3310
210x36	210x32	2.15	2207	2230	2140	2080	3020	3460
216x37	216x33	2.2	2311	2330	2240	2180	3170	3630

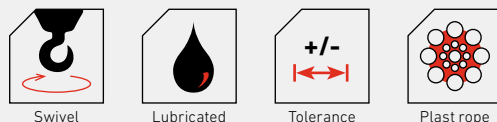
Values according to EN 12385-6:2004. Product specifications are subject to change without notice or obligation. The shown drawings or cross sections are only for illustrative purposes; the images can vary depending on requested diameter and current status of technical development. This table is for reference only. Additional sizes available upon request.

CASAR PLASTIC COVERED ROUND BALANCE ROPES

- Koepe Tail / Balance Rope
- Conventional strands
- Rotation resistant
- Designed to have a specific unit weight
- Impregnated and coated with tough polymer, offering superior protection against the harsh, aggressive environment of an underground mining shaft.
- Available in ordinary (regular) lay or langs lay

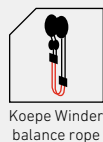


PROPERTIES



APPLICATIONS

Our proven and reliable plastic impregnated and coated round rope is perfectly designed to operate as a balance (tail) rope on a koepe friction winder application. The tough polymer provides a superior protection against the harsh, aggressive environment of an underground mining shaft.



Inner, nominal diameter		Outer, nominal diameter		Weight		Minimum Breaking Force	
mm	inch	mm	inch	kg/m	lb/ft	kN	lbs
30	1 3/16	37	1 7/16	3.65	2.45	467	105,000
32	1 1/4	38	1 1/2	4.84	3.25	512	115,000
33	1 5/16	40	1 9/16	5.13	3.45	534	120,000
35	1 3/8	41	1 5/8	5.71	3.84	649	146,000
37	1 7/16	43	1 11/16	6.10	4.10	734	165,000
40	1 9/16	46	1 13/16	7.10	4.77	823	185,000
41	1 5/8	48	1 7/8	7.89	5.30	912	205,000
43	1 11/16	49	1 15/16	8.14	5.47	979	220,000
44	1 3/4	51	2	8.75	5.88	1032	232,000
48	1 7/8	54	2 1/8	10.04	6.75	1192	268,000
51	2	57	2 1/4	11.43	7.68	1352	304,000

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Special constructions and diameters available – please contact us directly.

CASAR MINING ROPES IN CHINA

In China, too, the productivity and safety of a mine has top priority. With high-performance ropes from Casar, unlimited possibilities open up for mining operators.

Several years ago, CASAR's mining sales and technical group began seeking a partner in the Chinese coal industry to test CASAR's high performance mining ropes. After several visits and technical evaluations on their winding system, Huainan Mining Industry Group, one of the largest mining groups in China, agreed to test CASAR ropes.



In the mining industry, shutting down equipment for a few days to replace ropes is extremely costly. These maintenance breaks could take place every year which adversely affects the mine's profit.

It is a huge benefit to a mine to be able to run the machines longer between the rope's replacements. Huainan Mining's target was to reach a rope lifetime that enables the mine to extend the time between scheduled rope changes to two or probably three years. When CASAR first met with them they could not reach year two on the com-

petitor's ropes so they often changed ropes after one year to avoid an unscheduled breakdown.

The high performance hoist rope CASAR Turboplast MF was installed on the 4-rope, ground-mounted friction winder system replacing some flattened strand mining ropes. These are the first CASAR Special Mining Ropes operating in China and the first mining ropes with a steel core operating in the Chinese coal mining industry.

The 56mm Turboplast MF was challenged at one of the most productive and heaviest duty coal mines in the country. Supplied for a field trial test, this CASAR rope not only achieved the targeted service life but also set a new mine record – off the cuff – in terms of rope service life and production capacity achieved for a given rope set.

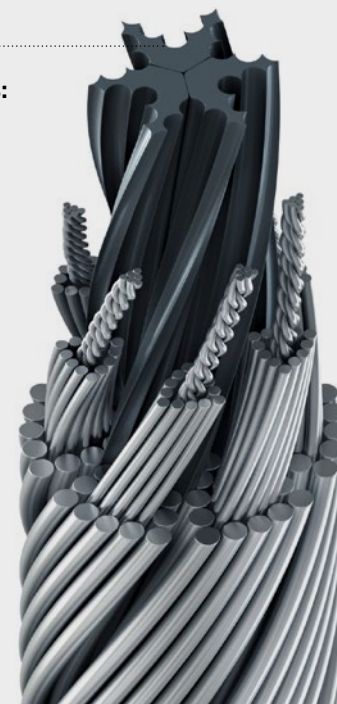
Huainan's mine transports more than 13 million tons of hard coal per annum. This makes the hoisting system one of the highest production capacity hoists not only in China but also worldwide.



3 TIMES LONGER SERVICE LIFE SCHEDULED

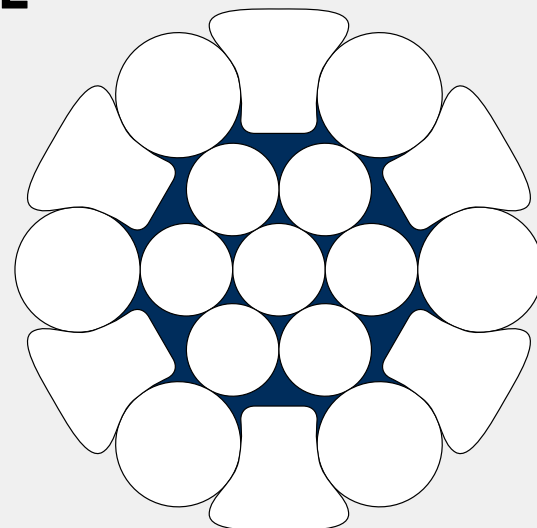
Turboplast MF Tonnage:
8 Mill. Tons
Turboplast MF scheduled rope changes:
2 or probably 3 years

Competitor's ropes:
changed every year



CASAR HALF LOCK COIL ROPE

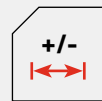
- Guide or rubbing rope
- Round and shaped wires
- Special design to increase wear and corrosion resistance
- Conforms to EN12385-7



PROPERTIES



Lubricated



Tolerance

APPLICATIONS

Our half locked coil guide ropes according to EN12385-7 standard are available in various sizes and designs, but can be modified to meet the individual requirement. This rope design is used as guide or rubbing ropes for underground mining applications.

Nominal Diameter		Weight		Aggregate Breaking Force	
mm	inch	kg/m	lb/ft	kN	lbs
29		4.6	3.09	455.4	102,378
32		5.6	3.76	554.1	124,567
35		6.7	4.50	663.4	149,139
38		7.9	5.31	784.4	176,341
41		9.3	6.25	909.7	204,510
45		11.1	7.46	1093.3	245,785
48		12.7	8.53	1241.9	279,192
51		14.3	9.61	1411.7	317,364

Product specifications are subject to change without notice or obligation. The shown drawings or cross sections are only for illustrative purposes; the images can vary depending on requested diameter and current status of technical development. This table is for reference only. Additional sizes available upon request.

CASAR ROPES FULLY PROVE THEIR PERFORMANCE IN SIBERIAN MINE

CASAR has now, for a number of years, been a supplier to the most important and biggest mining company in Russia, Norilsk Nickel. We started with two trial deliveries in 2016 and 2017. The first being the Taymyrsky mine (picture) where we installed the 43.5mm Starplast MF rope design with lengths of 1,650m each.

This test trial was successfully completed in 2019. The Starplast MF increased the service life by 80% when compared to the hoisting rope previously used and supplied by a competitor. The rope was removed from service at the end of the trial period, without having deteriorated to the extent that necessitated discard. After the test trial of this set the deliveries of this type of ropes for the hoists of Norilsk Nickel have become regular.

Norilsk Nickel provided us with several test lengths of the Starplast MF for further analysis here at Kirkel. Nearing conclusion of these rope examinations, the Norilsk Nickel engineers and employees of the in-house test laboratory were invited to Kirkel. We shared with the visitors the test results that had already been completed and dismantled a test sample, wire by wire, in their presence. The inspection revealed a rope whose condition can be described as almost new, even though the test sample was selected from the most severe stressed zone on the rope. In the end, we were able to not only confirm the promised and expected rope service life, but also convinced the customer to use our product forthwith, due to the excellent condition of the rope after the period of service and, above all, the extra margin of safety and reserve strength towards the end of life.

The trial phase of the second delivery was also successfully completed at the end of March 2021. In July 2017, Norilsk Nickel installed a set of 41.5mm Stratoplast MF in lengths of 850m each in the Komsomolskiy mine, also a Koepe hoist (Friction Winder).

After a period of three years and eight months and having hauled more than seven million tons, the Stratoplast MF was also able to complete the test phase with great success and was replaced by a new set of Stratoplast MF for normal winding operations.

In addition to the significant increase in service life, Norilsk Nickel was also impressed with the reduction in operating costs possible with our hoisting ropes, as less interventions were required due to rope elongation cuttings, exceeding rotation and cleaning the rope and hoist due to excessive lubrication.

Besides, CASAR has also been approved as a permanent supplier of flat ropes (as balance or tail ropes), manufactured by our Polish colleagues at Drumet, mostly by hand.

Starplast MF

80% INCREASED SERVICE LIFE

previously used rope



HIGH-PERFORMANCE MINING ROPES

Hoisting ropes in all mining operations play a safety-critical role in the production cycle, not only to hoist minerals but, also to transport employees and materials efficiently and safely.

CASAR specialises in this technology and is the global leader in the manufacture of sophisticated wire rope products, for a broad range of lifting applications. We believe we can offer value to the mine's business, through our innovative technology, manufacturing skills, and expertise.

1. THE HIGH-PERFORMANCE MINING ROPE

The Wire Rod and Rope Wire

The majority of rope wires are made from well-defined carbon steel with contents of carbon and manganese up to 1%, phosphorus and sulphur up to 0.5% and silicon between 0.1% and 0.3%. The raw material for rope wires is wire rod of 6mm to 9mm diameters. This rod wire is processed to the required rope wire diameter and strength as well as wire shape. The cold forming drawing and rolling process is able to achieve for instance rope wire diameter tolerances of 0.01mm.

Most wire ropes are made with uncoated (bright) high-carbon steel wires. Galvanized wire is often used to improve the corrosion resistance of wire ropes. The following two types are used:

Galvanized-to-finished size wire starts as a smaller diameter bright wire and is then coated with a zinc layer that increases the diameter to the designed finished size.

Galvanized-to-finished wires are 10% lower in strength than the same size and grade bright wire. Therefore, ropes made with these wires have minimum breaking forces that are 10% lower in strength when compared to their bright version.

Drawn galvanized wire is bright wire galvanized just before it being drawn down to its final finished diameter. This leaves a much thinner zinc coating than is on galvanized-to-finished wires. Drawn galvanized wires are equal in strength to the same size and grade of bright wire. Therefore, ropes made with these wires have minimum breaking forces that are equal to their bright versions.

Traditional wire rope corrosion protection relies on pure zinc applied to the surface of the wires. Using a zinc-aluminum alloy is a significantly improved process when compared to the traditional galvanizing process. Combining the passive corrosion inhibition of aluminum oxidation with the active and passive effects of zinc results in approximately three times the amount of corrosion protection compared to standard zinc coated wires. The coating also provides an anodic feature that heals over the exposed steel when the wire is abraded or scratched.

According to EN 10264, ungalvanized wires (often specified as bright wire or uncoated wire), are specified with the letter "U". Rope wires with a zinc coating are either specified with a letter "A" or a "B", depending on the coating mass. Additionally, there are rope wires with a Zn95/Al5 coating available.

Furthermore, where bright wires are replaced with galvanized wires for the inner wires and core wires, such a rope can still be classified as bright or ungalvanized. For a galvanized rope, all wires, including the core, need to be galvanized.

Besides the wire coating, there are different shapes of rope wires used. Round rope wires certainly have a round shape and all wires, which are made with a shaped cross-section (i.e. not round) are defined as profiled wires.

A further specification for rope wires is the tensile strength. The tensile strength is a fraction of the maximum axial force that can be applied to the wire before breaking and the cross sectional metal area of the wire. Usually, the rope wire is defined with a nominal tensile strength, which is confirmed by the actual tensile break test, where the actual strength may not undermatch the nominal strength. Nominal tensile strengths for mining rope wires are specified in several steps, between 1370 N/mm² and 2160 N/mm².

The choice of tensile strength of mine winder ropes primarily depends on the breaking load required. Mine winder ropes manufactured from wires with a 1770 N/mm² and 1960 N/mm² tensile grades, provide approximately the same level of useful service life, when operated under similar conditions. Mine winder ropes manufactured from wires with a tensile grade, greater than 1960 N/mm², should only be used if the breaking load required, cannot

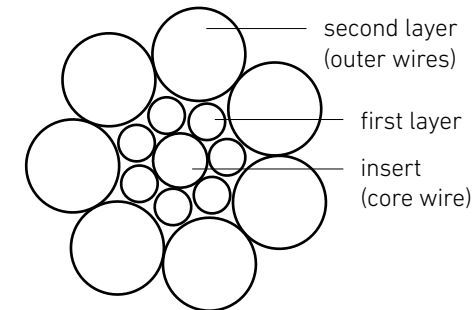
be achieved by any other means, such as selecting a rope design or size with a higher metallic area.

The hardness of the wires typically ranges between 500 to 650 HV.

The wires referred to as "Outer Wires" are positioned in the outer layer of wires in a spiral rope or the outer layer of wires in the outer strands of a stranded rope. A layer of wires is the assemblage of wires with the same pitch circle diameter. Filler wires (or fibers) are not considered and don't represent an individual layer.

The Rope Strand

Wires are the basic building blocks of a wire rope. They lay around a "center" in a specified pattern in one or more layers to form a strand. The strands are helically laid together around a center, typically some type of core, to form a wire rope.



Properties like fatigue resistance and resistance to abrasion are directly affected by the design of strands. In most strands with two or more layers of wires, inner layers support outer layers in such a manner that all wires may slide and adjust freely when the rope bends.

As a general rule, a rope that has strands made up of a few large wires will be more abrasion resistant and less fatigue resistant than a rope of the same size made up of strands with many smaller wires.

Round Strand

Round strands are defined as strands with a circle shaped cross section and triangular strands are shaped approximately like a triangle.

Single Layer

The most common example of single-layer construction is a 7 wire strand. It has a single-wire center with six wires of the same diameter around it.

Seale Construction

This construction has two layers of wires around a center with the same number of wires in each layer. All wires in each layer are the same diameter. The strand is designed so that the large outer wires rest in the valleys between the smaller inner wires. Example: 19 Seale (1-9-9) strand.

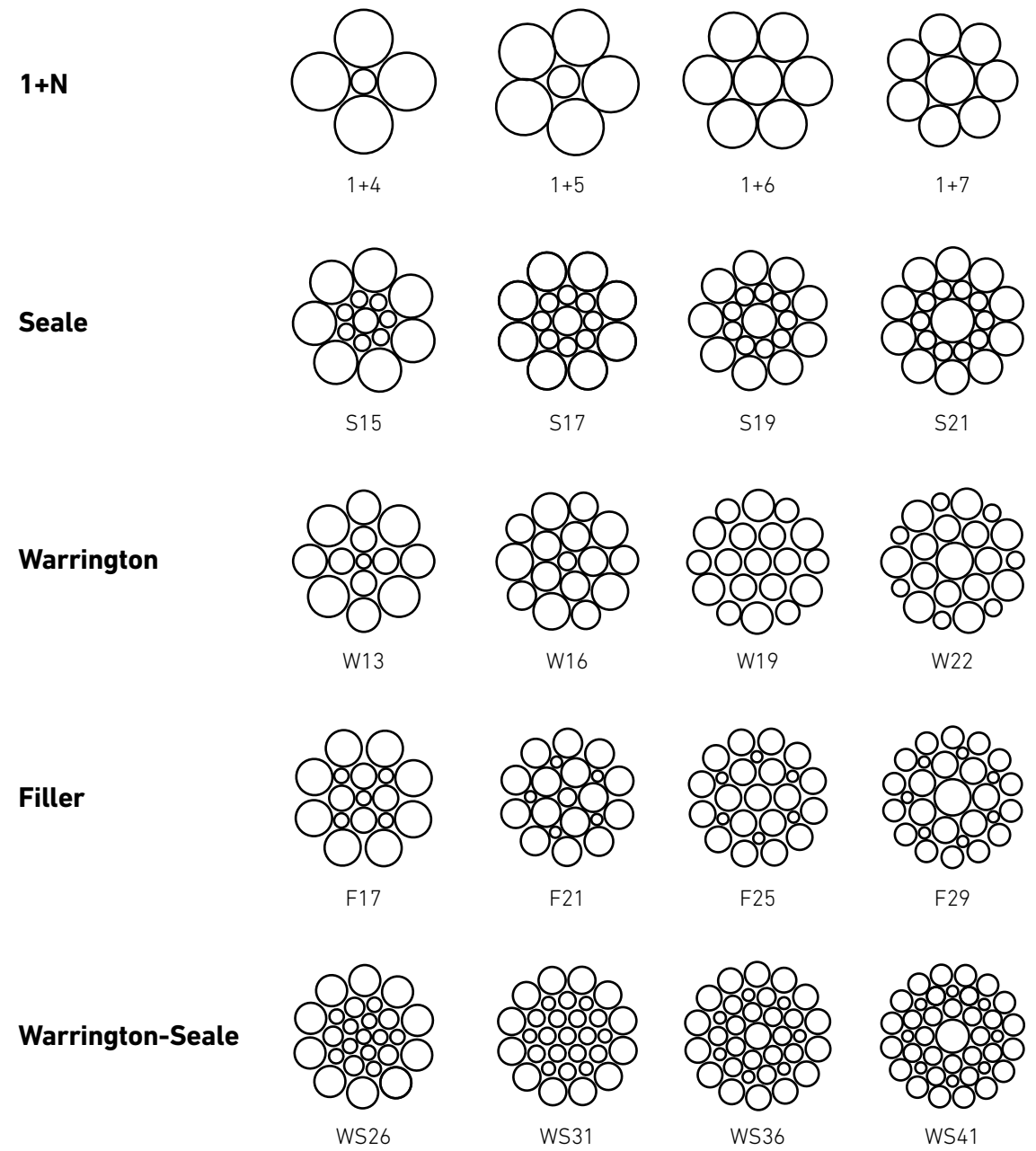
Warrington Construction

This construction has two layers of wires around a center with one diameter of wire in the inner layer, and two diameters of wire alternating large and small in the outer layer. The larger wires in the outer layer rest in the valleys, and the smaller ones on the crowns, of the inner layer. Example: 19 Warrington [1-6-(6+6)].

The majority of rope strands are one-, two- and three layer standard as well as parallel-lay designs. Standard designs are manufactured with wire crossovers within the wire layers of the strand. Parallel-lay strand designs, such as Filler, Seale, Warrington or Warrington-Seale, are manufactured with all wire layers stranded in one operation with the wire same lay lengths, and avoid wire crossovers with wires laid in line contacts.

construction type	symbol	examples of strand construction
Single lay	No symbol	6 i.e. (1-5) 7 i.e. (1-6)
Parallel lay		
Seale	S	17S i.e. (1-8-8) 19S i.e. (1-9-9)
Warrington	W	19W i.e. (1-6-6+6)
Filler	F	21F i.e. (1-5-5F-10) 25F i.e. (1-6-6F-12) 29F i.e. (1-7-7F-14) 41F i.e. (1-8-8-8F-16)
Combined parallel lay	WS	26WS i.e. (1-5-5+5-10) 31WS i.e. (1-6-6+6-12) 36WS i.e. (1-7-7+7-14) 41WS i.e. (1-8-8+8-16) 41WS i.e. (1-6/8-8+8-16) 46WS i.e. (1-9-9+9-18)
Multiple operation lay (round strand)		
Cross lay	M	19M i.e. (1-6/12)
Compound lay*	N	37M i.e. (1-6/12/18) 35NW i.e. (1-6-6+6/16)

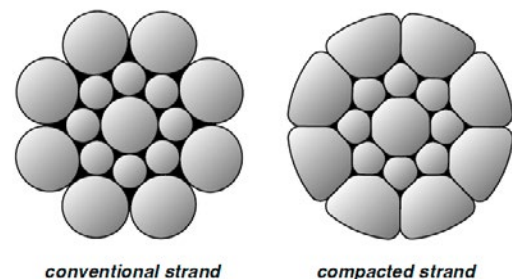
* N is additional and precedes the basic type symbol, e.g. Compound Seale is NS and Compound Warrington is NW



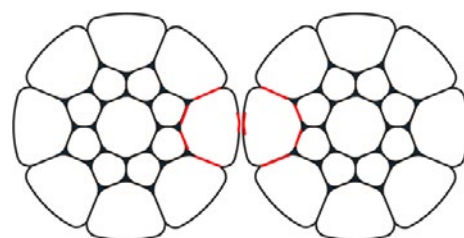
Compacted Strand

Casars Special Wire Ropes are made out of both conventional strands and compacted strands, determined by the application and rope properties required.

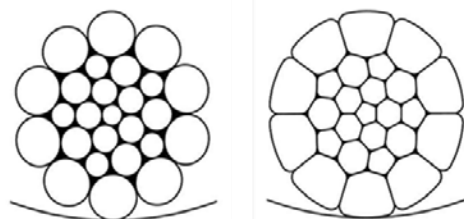
To produce a compacted strand, a conventional strand made out of round wires is drawn through a compacting tool. During this procedure, the wires are plastically deformed, the strand diameter is reduced and the surface is made smooth. The contact conditions between the individual wires and the strand-to-strand contacts improve.



As per definition, the fill factor is the ratio of the sum of the nominal metallic cross-sectional areas of all the wires in the strand and the circumscribed area of the strand.

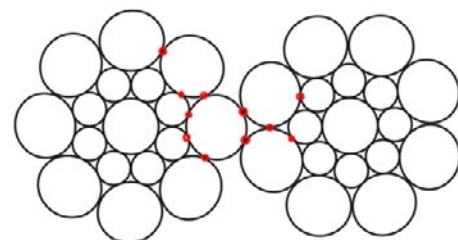


While conventional strands are designed with a fill factor up to 0.82 (or 82% amount of steel in the strand, depending on the strand design, e.g. Seale, Warrington Seale, etc.), the strand compaction can achieve fill factors of 0.90 and more.



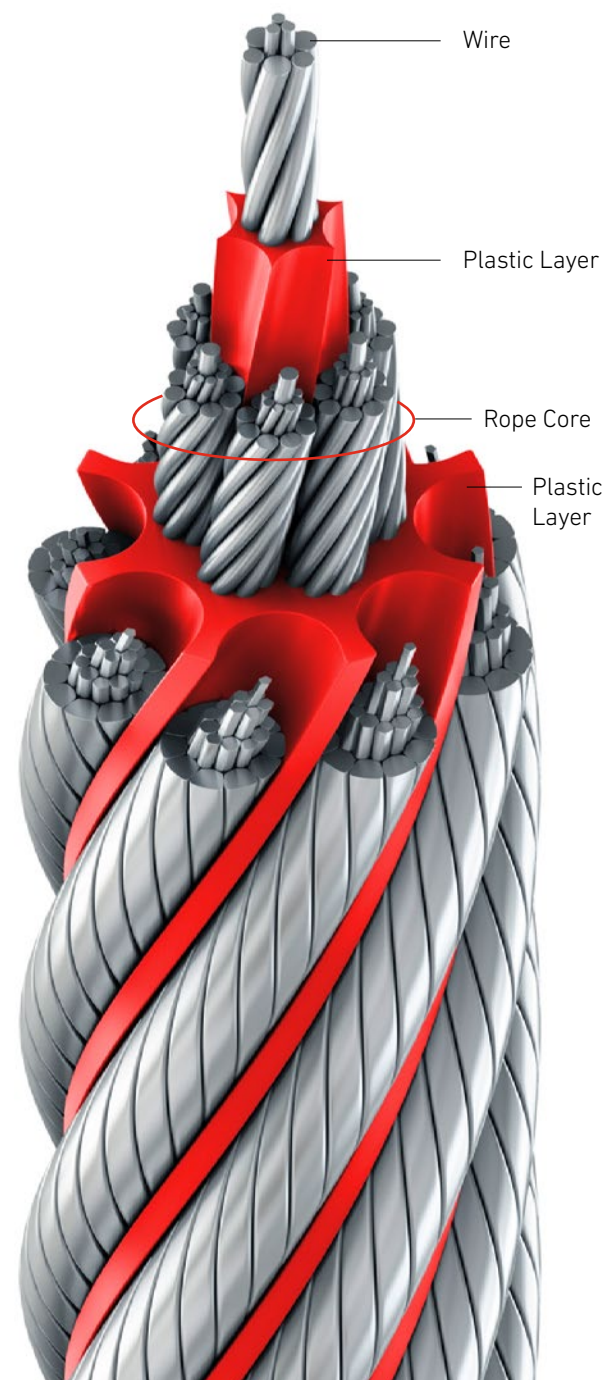
Ropes made out of compacted strands have a higher breaking load, greater flexibility and better rope-to-sheave contact conditions than comparable ropes made out of conventional strands. Because of the larger outer wires and the smaller exposed area they are more resistant to abrasion and corrosion.

With the compaction of rope strands, the metallic cross section of the strand is increased. Therefore, the compaction of rope strands increases the amount of steel within a certain space, which the strand represents in the wire rope designed cross section.

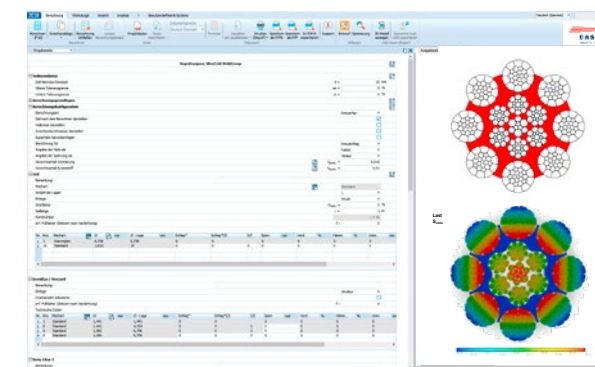


The Wire Rope

A rope is an elongated, flexible, elastic element made of strands or wires laid up in a helix around a core for transferring tensile forces.



CASAR uses calculation programs and computer-aided tools such as CAD and FEM to design the strands and the rope. Properties such as the elongation behavior, torque or design parameters such as the lay length ratio are also validated by empirical tests in the laboratory and enable advanced dimensioning and optimization specific for the application.



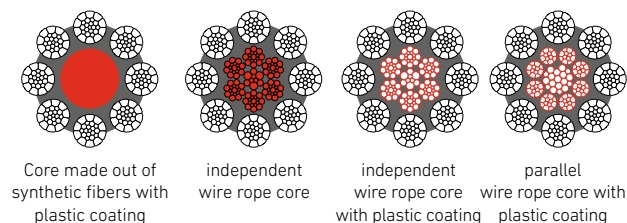
As described, a wire rope consists of a large number of helically twisted wires or strands. Combined, the inner strands form the core or the heart of the rope. The outer strands usually give the entire rope its name and form the top layer. The outer strands of the CASAR special wire ropes are arranged helically around a core in accordance with strict geometrical laws. In turn, stranded wires, manufactured independently of – or in parallel with the outer strands are used as the core. The core is in most instances encased with a plastic layer. In addition, this plastic layer is heated during the final closing of the rope, to allow the outer strands to bed into the plastic layer. Thanks to the positive service life properties, the rope designs offer an extended range of applications (see also chapter “Plastic insert”).

The structure of a rope is described by the number of its elements, e.g. for a rope with 8 outer strands of 26 wires each, the designation is “8 x 26”.

Parallel stranding offers significant advantages over single-layer stranding due to the linear contact of the wires. The stress on the wire is reduced through the distribution of the internal pressures and significantly longer service lives are achieved.

The geometry of the strands is named after their inventor, Seale, Warrington and Filler, as well as the

composite design, Warrington-Seale. In addition to the classic fiber cores and steel cores, fiber cores made of high-strength, high-molecular, synthetic plastics are also used today, which, in contrast to the classic fiber core, are load-bearing (CASAR Turbolite M).



The different core types are defined e.g. in EN 12385. Core types are natural fiber core (NFC), synthetic fiber core (SFC) or a steel core (WC). Steel core designs are either a wire strand (WSC) or an individual wire rope (IWRC). A steel core, in which strands are parallel layed with the outer strands is specified with PWRC.

For steel wire ropes with a polymer covered core, for instance an independent wire rope core, the specification EPIWRC is used.

In the case of compacted core rope strands or compacted rope cores, there is a "K" added to the specification.

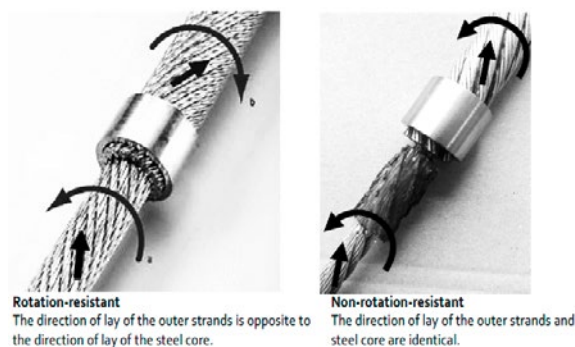
Item or element	Symbol
Single layer rope:	
Fiber core	FC
Natural fiber core	NFC
Synthetic fiber core	SFC
Solid polymer core	SPC
Steel core	WC
Wire strand core	WSC
Independent wire rope core	IWRC
Independent wire rope core with compacted strands	IWRC(K)
Independent wire rope core covered with a polymer	EPIWRC
Parallel-closed rope:	
Parallel wire rope center	PWRC
Parallel wire rope center with compacted strands	PWRC(K)
Rotation-resistant rope:	
Central element	
fiber center	FC
Wire strand center	WSC
Compacted Wire strand center	KWSC

Rotation-Resistant and Non-Rotation-Resistant Ropes

A helically twisted wire rope tends to "untwist" to reduce its torque under load. The result is that every wire tends to rotate under load.

In a conventional or non-rotation resistant rope that consists of at least 2 strand layers that are twisted around the core in a helical form, the direction of lay of the outer strands matches that of the inner strands. All strands generate a torque under load that is directed in the same, i.e. opening, direction and the rope starts to twist or rotate.

A rotation-resistant rope has a steel core that functions as an independent rope and is closed in the opposite direction like the outer strands. Under load, the steel core tries to untwist in one direction while the outer strands try to untwist in the opposite direction. The rope is designed in a way so that the torques of the steel core and the outer strands compensate over a wide load range and thus almost no rotation occurs even at a great lifting height.



The rotation resistance is mainly defined in two categories. As per ASTM A1023 the category 1 specifies rotation resistant rope types with in ISO 2166 defined rotation under load of less than or equal to 1 turn per length of 1000 times the rope nominal diameter (d) lifting a load equivalent to 20% of the rope minimum breaking force.

A category 2 rotation resistant rope, also referred to as semi rotation resistant, has a specified rotational property between 1 turn and 4 turns (per length of 1000d and a load of 20% MBF).

Low-tension Wire Ropes / Preformed Ropes

Many non-rotation resistant ropes are preformed during manufacture. While the strands of rotation resistant ropes are forced to the helical form during manufacture and keep their inner forces, the preforming operation is forming the strand to the helical form before closing into the rope. Therefore, the preformed strands are closed to the rope almost without remaining tension.

Locked Coil Ropes / Guide Ropes

Guide ropes and rubbing ropes for mining applications are usually locked coil rope types, mainly half-locked coil rope designs. This rope design is a spiral rope with a covering, outer layer of alternating shaped and round wires (half-lock). The shaped wires are called H-shaped wires. The advantage of this rope type is the big outer wire size, suitable for the guiding and rubbing usage.

Flat Ropes / Balance Ropes

Today, flat rope types are used as balance (or tail) ropes for Koepe friction winder applications. The flat ropes are an assembly of individual ropes known as reddie, usually made out of four strands. The majority of flat rope are designed with 6.8 or 10 reddie in alternating left and right lay direction, which are either stitched together side by side by wires, strands or rivets.

Wire Rope Diameter

When dimensioning new rope winders, the wire rope diameter is usually secondary to the required breaking force. On the other hand, in the case of an existing rope winder, the rope diameter is usually the first selection criterion. In both cases, however, it is important for the user to distinguish between the nominal diameter and the effective diameter and to understand the difference. The effective diameter results from the nominal diameter plus a certain design tolerance. CASAR special wire ropes are manufactured in a tolerance range between + 0% and + 5% (EN 12385). The rope diameters are usually at the upper tolerance limit, i.e. between + 2% and + 4%.

CASAR special wire ropes thus meet the requirements of all the renowned winder drum manufacturers and can be used on their products without reserve. However,

limited tolerances and special tolerances can also be produced on request.

Length of Rope

According to the EN 12385 standard, the actual delivered length of the unloaded rope must correspond to the nominal length, whereby the following tolerances apply:

For a length of up to 400m: 0% to + 5%

With a length between 400 and 1000m: 0m to + 20m

For a length over 1000m: 0% to + 2%

Different length tolerances can be produced on request.

Direction of Lay

The wires in the strands and the strands of a rope always follow a winding direction or lay direction. This can be either left or right hand. When you look down a rope, strands of a right lay rope go away from you to the right. Left lay is the opposite. (It doesn't matter which direction you look.) The direction of lay is denoted by the letters Z for right-hand and S for left-hand.

Type of Lay

Wires and strands can be laid in the same (Lang's lay) or opposite (Ordinary lay) directions, depending on the required rope properties. The distinction between the direction and type of lay between wire and strand is made using lowercase and uppercase letters.

Ordinary Lay

The wires in the outer strands are laid in the opposite direction to the outer strands in the rope. As a result, the wires are practically in one axis with the rope itself. The designation is sZ or zS, with the capital letter for the strand in the rope and the lower case letter for the wire in the strand. Ordinary lay is more resistant to kinking and untwisting, and less likely to fail as a result of crushing and distortion.

Lang's Lay

Both the wires in the strands and the strands themselves have the same lay direction. The wires are at a clear angle to the axis of the rope. The designation is zZ or sS.

Choosing the right lay direction is very important for the correct operation of a rope winding drum. Wrong lay direction can lead to a build-up of twist, spooling problems

and structural changes within the wire rope. The advantage of using Lang's lay is that the rope offers a better wearing surface when in use, and therefore can be expected, in many cases to last longer. Lang's lay ropes produce higher torque values under working conditions.

Ordinary lay ropes offer a higher structural stability and can withstand higher radial forces. The allowed number of broken wires as per the rope discard criteria is higher and a broken wire is easier to identify, remove and is less likely to damage neighbouring wires.

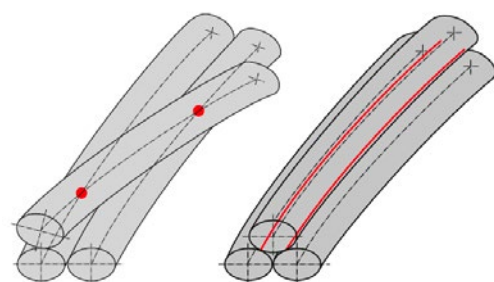
Langs lay ropes offer a superior wear and abrasion resistance as well as a much better multi-layer spooling performance. Langs lay ropes have a better contact in the drum and sheave grooves and can achieve a longer service life.

Lay Length

The lay length describes one revolution of a wire around the strand axis or one revolution of a strand around the rope axis. The lay length is thus comparable to the pitch of a spring. It is one of the decisive constructive parameters: long lay lengths result in a rather stiff rope, short lay lengths result in a very flexible rope. The correct lay length also has a major influence on rope elongation and rope service life. Changes in the lay length during operation of the rope can also indicate that the rope has neared the end of operational life.

Parallel Lay

In a cross - (non-parallel) lay strand, all wires have different lay lengths and a cross - (non parallel) lay rope, all strands have different lay lengths. The high stress concentration at the crossover points leads to premature internal failure.



cross (non-parallel) lay
stress concentration

parallel lay
stress distribution

In a parallel lay strand, all wires have the same lay length, and in a parallel lay rope, all strands have the same lay length. The linear contact leads to an optimal stress distribution. The case of unequal lay strands of non-circular cross-section(s), increases the complexity of the analytical analysis significantly. McKenzie (1989) noted that the complication in modeling mine winder steel wire rope strands arises from the non-uniform path of a wire around the strand axis. Conceptually, as a wire is followed, the radial distance between the wire and the strand axis changes from a maximum at the apices of the triangle, to a minimum along the flattened sides. Resultantly, varying contact surface areas, between individual mine winder rope elements, can be expected. However, in the instance of equal lay wires/strands, the associated degradation mechanisms are eliminated, as contact surfaces between the individual mine winder rope elements, are in parallel and react uniformly with changes in the lay length of the mine winder rope.

Lubrication

It is a misconception that, galvanized mine winder ropes do not have to be lubricated. The zinc coating only fulfils one of the two tasks that a lubricant performs, i.e. protection against corrosion. A lubricant is also required to reduce the friction between the large number of the mine winder rope's elements in contact with each other within the rope, and on the outside whilst running over sheaves and wound onto the winder drum. This requirement can only be achieved by the zinc coating in a very insubstantial way. Although static galvanized mine winder rope(s) can be applied without lubricant, a running mine winder rope will have a reduced useful service life, unless lubricated on a regular basis. If required, mine winder ropes can be galvanized (Category 2). To provide the additional required protection against corrosive elements, and act as a lubricant to minimise abrasive wear, mine winder ropes are lubricated during manufacture, with Elaskon SK-39/07oL. It is recommended that the mine applies Casar recommended lubricants for in-service lubrication, i.e. Elaskon SK-39/07oL.

These lubricants are specially formulated adhesive lubricants for the maintenance of mine winder ropes. The lubricant contains anti-wear, anti-rust, mild extreme pressure additives and deep penetrating wet ability agents. The additive treatment in these oils, protects the mine winder rope against water wash off and penetrates into the mine winder rope strands, guarding against corrosion.

Corrosion Protection

If required, ropes can be hot-dip galvanised or electro-plated to provide additional protection against corrosion. To provide the additional required protection against corrosive elements, and act as a lubricant to minimise abrasive wear, ropes will be lubricated during manufacture, with Elaskon II Star. It is recommended that the mine use CASAR approved lubricants for in-service lubrication. These lubricants are specially formulated adhesive lubricants for the maintenance of wire ropes. They contain anti-wear, anti-rust, mild extreme pressure additives, and deep penetrating wet ability agents. The additive treatment protects the rope against water wash off and penetrates deep into the rope strands, guarding against corrosion. These oils can contain a solvent and can be applied by spray, leaving behind a durable film of corrosion protection once most of the solvent has evaporated. It is applied at ambient temperature.

In addition, ropes are typically covered with Lamiflex on the drum reels, to provide for additional protection against harmful elements and corrosion, whilst in storage.

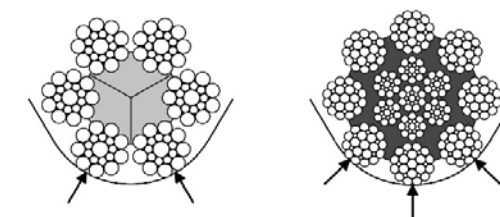
Size of Outer Wires

It is a known fact that, mine winder ropes with larger, more robust outer/crown wires, perform better in multi-layer spooling. The diameter of the outer/crown wires of a Seale 19 strand, is 42 % greater than those of a Warrington- Seale 36 strand. Their metallic cross-section is 100% greater and therefore, more robust and abrasion resistant. A significant degree of plastic deformation of the outer/crown wires is anticipated in this instance, specifically at the layer cross overs. Experience on mine winders with similar tread pressure(s), has shown that, should the plastic deformed section of the adjacent wires overlap each other, delamination of the outer surface of the wires can be expected. Larger outer/crown wires will allow for an additional amount of plastic deformation, before the

outer/crown steel surfaces of the outer/crown adjacent wires, come into contact with each other. However, fatigue performance is sacrificed and therefore, careful consideration has been applied in the selection of the optimum mine winder rope design.

Increased Number of Outer Strands

Increasing the number of outer strands results in a more flexible rope, another significant contributing factor towards resisting fatigue failures. Contact stresses between the outer strands and drum sleeves/sheaves as well as between the inner strand elements are also reduced by compaction of the strands. Internal protection against abrasion and harmful elements are provided by the plastic layer, and high contact stresses within individual strands (wires) and between the strands, is significantly reduced, by manufacturing all the strands and wires within the rope with an equal lay-length. The result is that all elements within the rope, work in unison to ensure no excessive contact stresses are generated in some of the strands or wires



The outer lay for the Turboplast MF is made up of eight (8) compacted outer strands. These eight strands are closed over an Independent Wire Rope Core (IWRC), with a protective plastic layer between the IWRC and outer strands and also protruding between the outer strands. All strands are compacted to allow for the maximum cross-section of steel for a given rope diameter. As a result, the increased cross-section of steel allows a similar reduction in stresses within the individual rope components and thus a significant increase in resistance to fatigue.

The Plastic Layer ...



... greatly lowers, or even removes, the incidence of birdcaging

... lowers the noise level whilst the rope is working

... prevents internal wire breaks

... prevents metal-to-metal contact

... absorbs dynamic energy

... stabilizes the rope structure

... prevents interstrand nicking

... seals in lubricant

... stabilizes the rope during the installation

... acts as a cushion between the layers

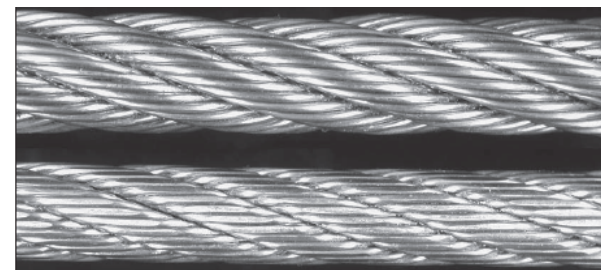
... keeps out water and abrasive elements

Swaged Ropes

Most of the damage a wire rope will be subjected to during multi-layer spooling is caused by the rough outer surface of the rope itself. So it would only seem logical to smoothen the rope surface to reduce the damage.

Steel wire ropes cross-sections are often referred to as being "round". But they are not round at all! Depending on the number of outer strands of the rope, the cross-sections resemble a hexagon or an octagon much more than a circle! The sequence of crowns and valleys along the circumference is the main cause for all the problems experienced by a multi-layered spooling winder rope. To improve the rope performance, we must attempt to make the rope cross-section round!

Casar has achieved tremendous round cross-sections and extremely smooth wire rope surfaces by hammering different types of steel wire ropes using a rotary swaging machine. Great care has been taken to avoid internal wire rope damage caused by the swaging process itself. The swaged ropes have been tested on normal bending fatigue machines and the Casar multi-layer test stand. The results have been very encouraging: On the multi-layer test stand, on average the swaged ropes achieved about 3 times the life of the comparable unswaged designs.



The same rope before swaging (top) and after swaging. Hammered ropes have much greater contact areas with the grooves of sheaves and drums than conventional steel wire ropes with a "rough" surface. This leads to much lower contact pressures and as a consequence to much lower sheave, drum and rope wear.

Casar offers a variety of hammered steel wire ropes. They can be identified in the Casar rope catalogues by the name ending "fit". Compared with conventional steel wire ropes, these rope designs offer an increased breaking strength and excellent rope life on multi-layer drums.

Overstressed Components

Any mine winder rope elements not reacting uniformly during loading results in such elements becoming overstressed. As an example, the use of a wire main core (WMC) or "King Wire" within the Independent Wire Rope Core (IWRC), can cause such a wire to become overstressed, in contrast to the rest of the mine winder rope. The reason is that all elements are laid up in a helical shape, whereas the WMC is a single wire, positioned in a straight plane in the core of the rope. As the rope elongates during normal cyclic service, this single wire will elongate significantly more than other elements laid up helically and could fail prematurely. An increase in mine winder rope steel area, with a constant payload, reduces stresses within individual elements and as a result, significantly prolongs the useful service life of such a mine winder rope. Stress concentrations within the outer/crown wires, due to plastic deformation, resulting in the premature fatigue failure of such a wire, is less of a factor, when the stress in such a wire is decreased, due to an increase in mine winder rope steel area.

2. TECHNOLOGICAL ADVANCE OF CASAR HIGH PERFORMANCE MINING ROPES

Following rope property definitions as per EN12385 can be found in our documentation:

- The rope grade (Rr) is defined as a level of requirement of breaking force which is designated by a number (e.g. 1770, 1960).
NOTE: It does not imply that the actual tensile strength grades of the wires in the rope are necessarily of this grade.
- Nominal metallic cross-sectional area (A) - the product of the nominal metallic cross-sectional area factor (C) and the square of the nominal rope diameter
- The fill factor (f) is the ratio between the sum of the nominal metallic cross-sectional areas of all the wires in the rope (A) and the circumscribed area (Au) of the rope based on its nominal diameter (d)
- The spinning loss factor (k) is the specified minimum aggregate breaking force (Fe.min) and the specified minimum breaking force (Fmin) of the rope, as determined from the ropemaker's design.
- Minimum breaking force (Fmin) – specified value in kN, below which the measured breaking force (Fm) is not allowed to fall in a prescribed breaking force test.
- Measured breaking force (Fm) – breaking force obtained using a prescribed method
- Minimum aggregate breaking force (Fe.min) – specified value, in kN, below which the measured aggregate breaking force is not allowed to fall in a prescribed test and normally obtained by calculation from the product of the square of the rope diameter (d), the metallic cross-sectional area factor (C) and the rope grade (Rr).
- Measured aggregate breaking force (Fe.m) – the sum of the measured breaking forces of all the individual wires taken from the rope
- Nominal rope length mass (M) – that value derived from the product of the length mass factor and the square of the nominal diameter.
- Measured rope length mass (Mm) – the mass of 1 m of rope as determined by weighing

Tolerances

CASAR Mining ropes are subject to tolerances outlined in EN12385.

Rope Breaking Force

Conventional steel wire rope constructions can meet a requirement for higher breaking loads only by increasing the tensile strength of the individual wires.

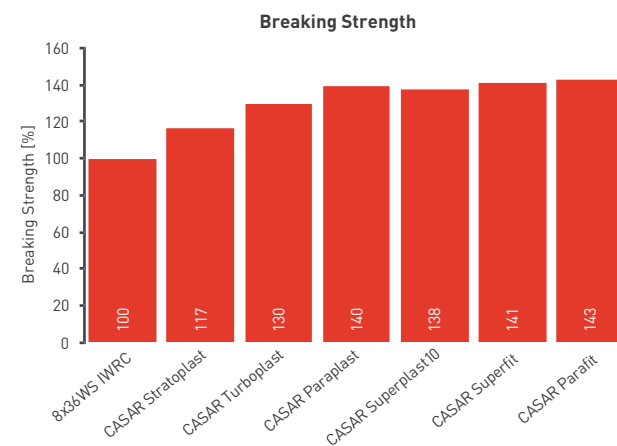
Casar Special Wire Ropes are already designed for the highest breaking loads by a combination of various technologies:

- A large number of strands increases the metallic area of the rope.
- Parallel lay leads to a more compact rope construction.
- A plastic layer reduces internal stresses.
- Compacting of the strands increases the fill factor of the rope elements.
- The tensile strength of the wires is chosen according to the requirements.

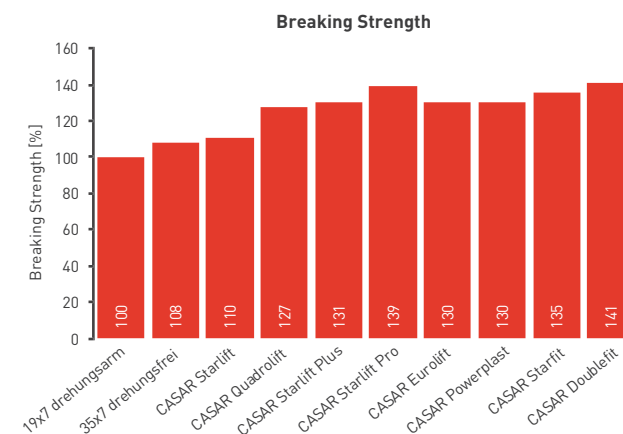
The high breaking loads of Casar Special Wire Ropes offer the user the following advantages:

- Design advantages by reducing the sheave and drum diameters and the size of motor and gearbox.
- Longer service life due to lower specific stress on the rope.
- Increased safety.

Comparison of Non-Rotation Resistant Ropes



Comparison of Rotation Resistant Ropes



The breaking forces and the fill factors of the CASAR special wire ropes are significantly higher than the breaking forces of the standard designs (DIN EN 12385-4).

The fill factor indicates the ratio between the metallic area of the perimeter of the rope and the actual area from the sum of the individual wires. A high fill factor usually leads to a higher breaking strength, but also increases the weight per meter. Especially the hammered FIT ropes stand out particularly.

Also with the rotation resistant ropes, the advantages of the highly specialized design and manufacturing knowledge are clear. The breaking forces actually achieved in the test are on average approx. 10% above the minimum breaking forces. This safety has proven to be economically advantageous for the user, since no unnecessarily high reserves are left unused in the design of the rope drive.

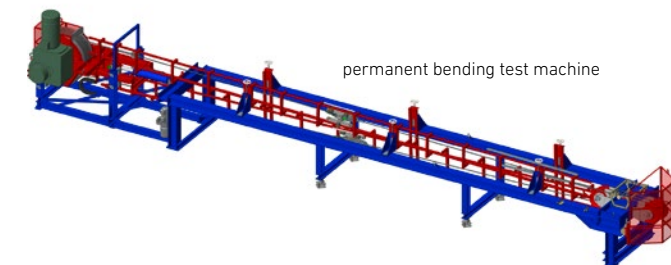
The bundling of wires into a strand and the strands into a rope is necessary in order to allow the necessary bending flexibility for the overrun of sheaves. The price paid for flexibility, however, is a loss in breaking strength versus a bundle of parallel wires. This loss caused by the helix shape is referred to as stranding loss. CASAR special wire ropes show extremely low stranding losses compared to the standard ropes.

Rope Fatigue

In addition to the breaking force, the service life of the rope is one of the main characteristics of CASAR special wire ropes.

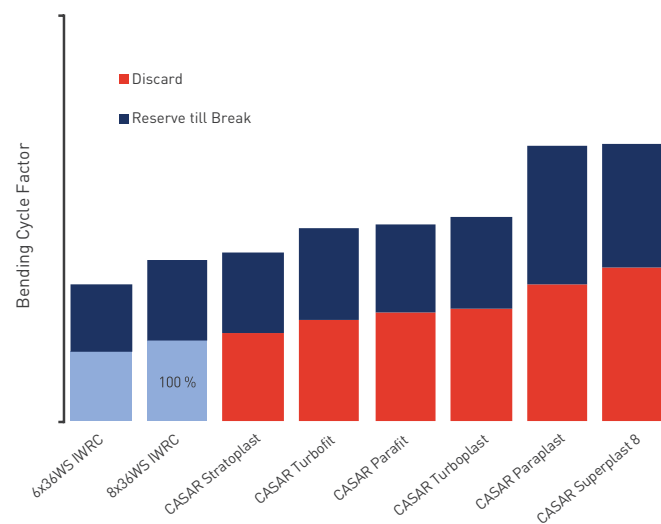
Compared to the standard, they are characterized by a significantly longer durability or rope service life as well as a high level of remaining safety before a strand or rope break occurs. The high number of bending cycles remaining after the discard status has been reached enables a timely rope change.

CASAR has a test lab with more than 10 testing machines, including 2 permanent bending machines. Above all, the principle of multiple bending per movement cycle has proven itself: While with classic continuous bending machines there is usually only one bending cycle per machine cycle, 5 sheaves are rolled over on the testing machine, i.e. 10 bending cycles.

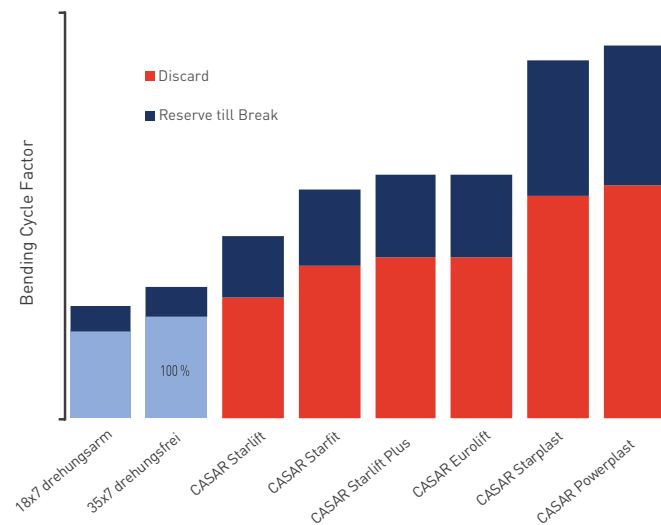


Following diagrams show the service life values determined in the laboratory on a permanent bending machine with the same relative loads and with the same diameter ratio (D / d = 20) for the non-rotation resistant CASAR ropes as well as the rotation resistant CASAR ropes.

Endurable Bending Cycles (non-rotation-resistant)



Endurable Bending Cycles (non-rotation-resistant)



Rope Rotation Behavior

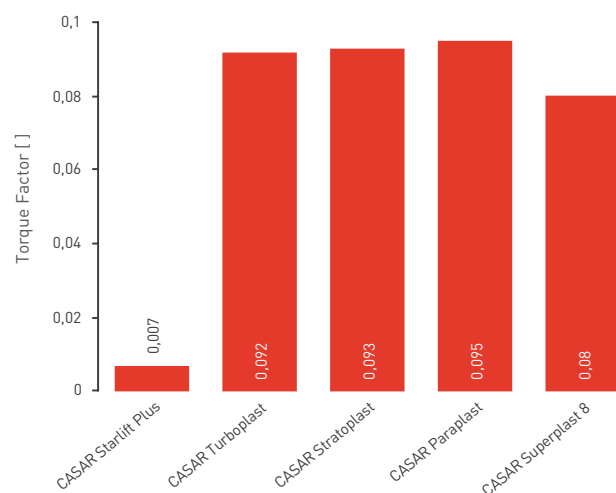
Conventional wire ropes try to untwist under load. Stability can often only be achieved by overloading the core of the ropes. Rotation-resistant Casar Special Wire Ropes are stabilized against rotation by various technologies.

- A wire rope core, closed in the opposite direction of the outer strands, creates a stabilizing moment.
- A compacted core increases the rotational stability.
- A favourable ratio of the metallic areas leads to stability without overloading the core.

The high rotational stability of Casar Special Wire Ropes offers the user the following advantages:

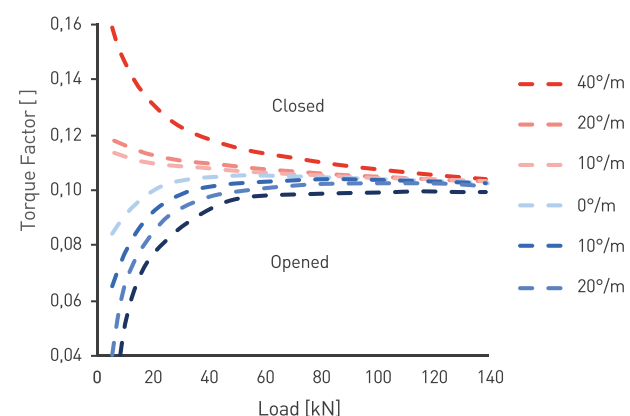
- No block rotation even with great lifting heights.
- Long service life because of an untwisted rope structure.
- Great safety in mining operations.

Torque Factors of Different CASAR Special Steel Wire Ropes



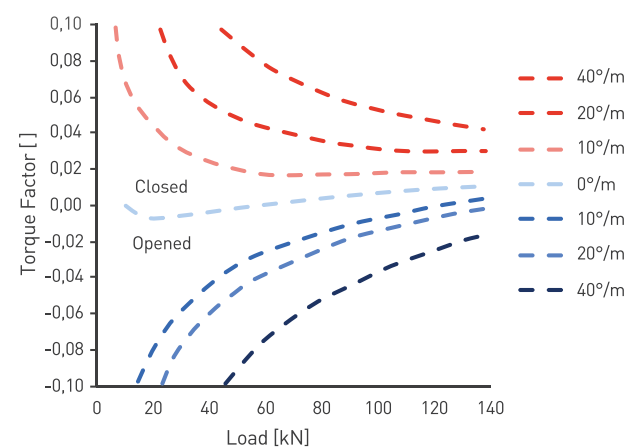
Rotation resistant ropes have a small torque factor, but build up a very high torque resistance when twisted violently. Non-rotation resistant ropes such as the Stratoplast naturally tend to untwist, but are more robust against violent twisting, for example due to larger deflection angles.

Torque factor of a non-rotation resistant rope as a function of the load for different angles of violent twisting (Casar Stratoplast d19 / 180):



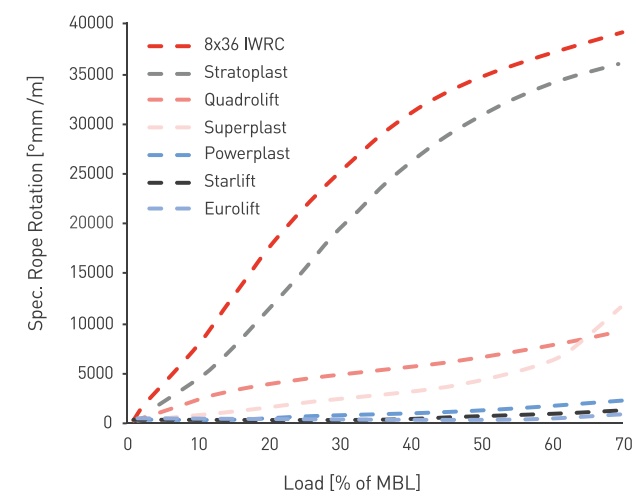
The torque factor is only marginally influenced by the twist. In contrast to this, the torque factor of a rotation resistant rope is significantly influenced by an external twist.

Torque factor of a rotation resistant rope as a function of the load for different angles of forced twisting (Casar Starlift d19 / 180):



Conversely, a measurable twist for each reference length can again be determined earlier in the case of non-rotation resistant ropes.

Specific rope twist (twist x rope diameter / rope length) depending on the load.

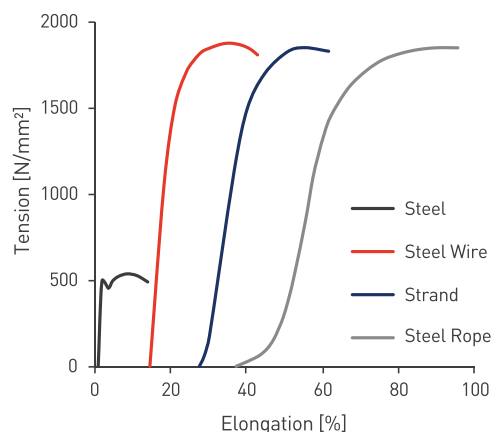


Rotation resistant ropes only show measurable twisting significantly above the loads that occur in use.

Rope Elasticity and Elongation

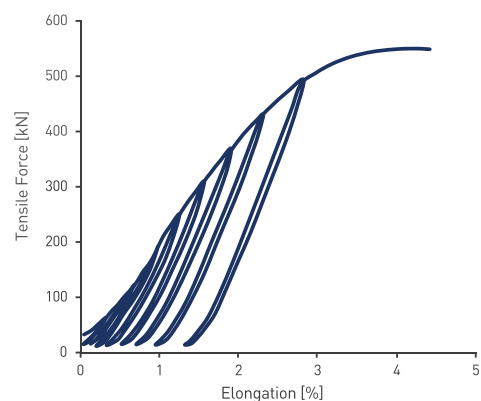
The wire rope manufacturing is stranding and closing the rope wires to the rope design. With the first loading of a new rope, all rope wires experience their first load and move very slightly in order to find their optimum places. This bedding in of the assembled wires results in an elastic and a remaining change in the rope diameter as well as the rope length. There is a certain reduction in rope diameter and with it a lengthening of the rope. With repeating the loading and unloading of the new rope as well as experiencing the first bending, the rope is lengthening until the bedding in is completed. This initial, remaining extension of any new rope is not accurately possible to be calculated and can amount up to 5%, which particularly depends on the rope construction and load. This is accompanied by a more or less distinctive reduction in diameter, depending on the rope's design.

Comparison of the stress-strain curves of steel, steel wire, stranded wire and steel wire rope.



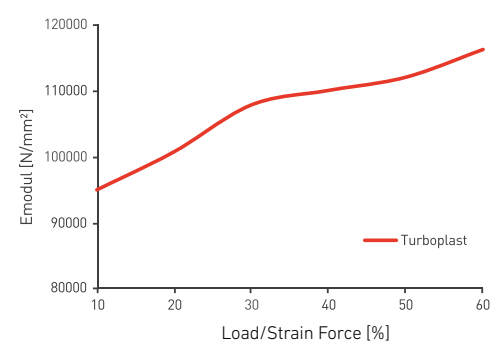
The actual elastic expansion is reversible and proportional to the load. A rope with a high E-modulus tends to be stiff, whereas a rope with a low E-modulus tends to have a high energy absorption capacity and is correspondingly less sensitive to shock loads.

Load/Strain diagram for a wire rope

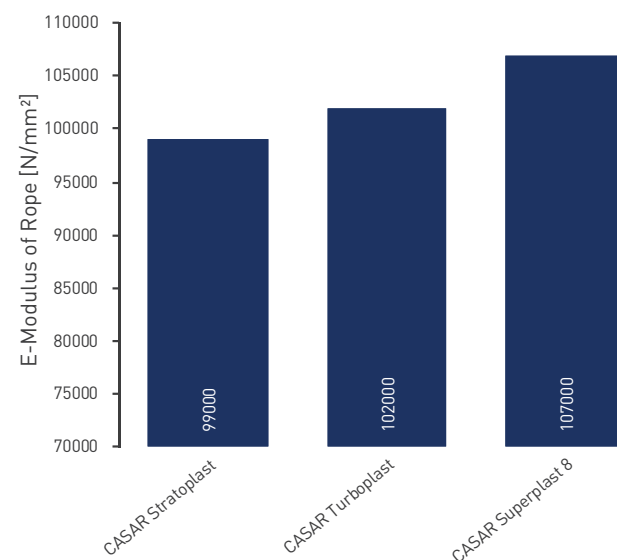


The following diagram shows the E-modulus for various CASAR ropes as the average value from the load between 10% to 60% of the MBL. In addition, the E-modulus was averaged over a diameter range from 16mm to 50mm.

Load/Strain diagram for a wire rope

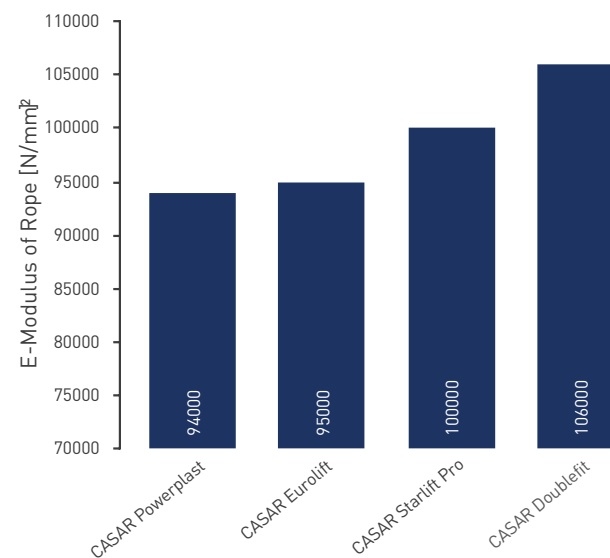


Rope E-modulus of non-rotation resistant CASAR Special Wire Ropes



The values for the E-modulus of the ropes are about half as high as the value of steel. The values given in the diagram are average values from a large number of tests with different diameters.

Rope – elastic modulus of rotation resistant CASAR Special Wire Ropes



The realistic figures are depending on many influences, most important the type of rope and rope design, the range of loads as well as the number and frequency of loading cycles of operation.

Conventional steel wire ropes often have insufficient modulus of elasticity and permanent elongations that are too high.

Casar Special Wire Ropes are optimized with regard to their stress strain properties by various features:

- The full steel construction provides a high modulus of elasticity.
- The compact rope structure guarantees minimal permanent elongations in the working range.
- The homogeneous load distribution on all rope elements creates high elongations at break.
- The plastic layer absorbs dynamic energy.

The balanced stress-strain properties of Casar Special Wire Ropes offer the user the following advantages:

- High rigidity of suspended structures.
- Less retentioning for suspended structures and positioning machines.
- High safety against dynamic failure.

Another important remark, with reference to rope elasticity, is that it does not possess a Young's Modulus of Elasticity. While a theoretical estimation of the elastic extension can be calculated (refer to below), a more accurate result is determined by a practical modulus of elasticity test measurement on an actual sample of a rope. This modulus of elasticity measurement is a usual part of our high performance mining rope quality assurance and is included in the sales order quality documentation.

$$Elastic\ Extension\ (mm) = \frac{F \cdot l}{E \cdot A}$$

with:

F = load (kg)

l = rope length (mm)

E = modulus of elasticity (kg/mm²)

A = circular area related to the rope nominal diameter (mm²)

Prior to comparing suitable mine winder rope designs, in relation to duty cycle calculations and mine winder rope useful service life prediction results, specific rope design attributes have been selected, in accordance with the key rope attributes identified, for this specific installation. To achieve the optimum mine winder rope useful service life, the main requirements identified during rope selection are summarised as follows;

A High Performance Multi-Stranded Rope

The simplest mine winder wire ropes are manufactured by closing steel strands around a central fiber core. In a new mine winder rope, the fiber core acts as an elastic bed for the outer strands and as a reservoir for the rope's lubricant. When subjected to high dynamic loads, the fiber core is compressed and the mine winder rope is lengthened, thereby reducing high peak loading. With increased useful service life, these advantages rapidly turn into disadvantages. The lubricant is squeezed from the fiber and replaced by water from the atmosphere. The mine winder rope's basic geometry is also altered, as the stability of the fiber core reduces over time. The fiber core reduces in diameter, leading to strand-to-strand contact and to early mine winder rope deterioration. Under high radial forces, the geometry of mine winder ropes, with a fiber core(s), is not sufficiently stable.

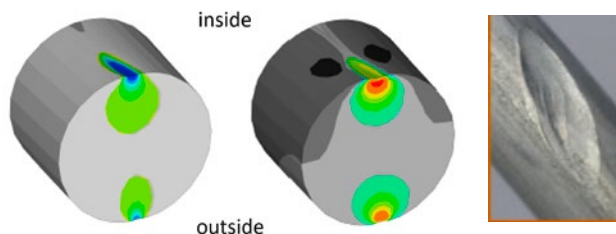
Multi layered full steel mine winder ropes have enhanced advantages. However, full steel mine winder wire ropes, with independent wire rope cores, are exposed to a number of contact pressure points between certain mine winder rope elements. Contact points, where strands of the core come in contact with the outer strands, cause internal damage. Double parallel mine winder ropes are specifically designed, where the inner and outer strands lie parallel to one another. This avoids the extreme crossover contact points found in conventional full steel mine winder ropes, which lead to premature failure. Due to the unique construction of Casar's multi-stranded mine winder ropes, denser compositions than conventional types achieve higher breaking loads.

As an example, WireCo's CASAR StarPlast VM is rotation resistant, essential for increased depth of wind Koepe Winder applications. The StarPlast was designed for increased depth of wind applications; a proven design, with a proven record. CASAR Starplast VM Rotation-resistant rope will find equilibrium, by shortening and lengthening of opposing layers (high torque resistance, limited negative rotation). However, stresses in opposing layers are near equal, as the product of the cross-section of steel and radii, is equal. High stresses between opposing layers are eliminated, as a negative torque factor will decrease pressure between the opposing layers at a position where normally the opposite can be expected! Furthermore, due to a protective plastic coating between these layers and the opposing layers reacting uniformly, rotation and subsequent slackening or over-tightening of strands, in the opposing layers, are reduced to a minimum

The increased number of outer strands of the rope results in a rope that, is more flexible, resistant to fatigue, and less prone to damage caused by external contact stresses. The rope's ability to withstand abrasive wear is also significantly improved as a result. Increasing the number of the outer strands results in a higher number of contact points and a subsequent reduction of contact stresses at every contact point. Although the size of the outer strands and as a result, also the outer wire diameter, is reduced, the effective contact area of the outer wires is increased, through compaction and thus more resistant against abrasion and corrosion.

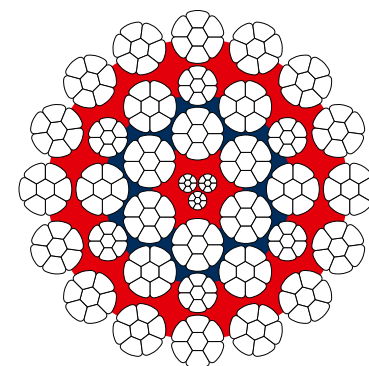
The high contact stresses within individual strands (wires) and between the strands in the IWRC are significantly reduced, by manufacturing all the strands and wires within the strands with an equal lay-length. The result is that all elements within the core of the rope, work in unison, to ensure no excessive stresses are generated in some of the strands or, wires.

By design, the contact stresses between the opposing directions of lay, are limited to a single plane, between the outer strands and IWRC. The stresses between these elements are eliminated by a plastic inlay, which prevents the respective strands from making contact and also significantly improving the rope's ability to withstand shock loads. The integrity of construction is also maintained during installation, by the plastic layer



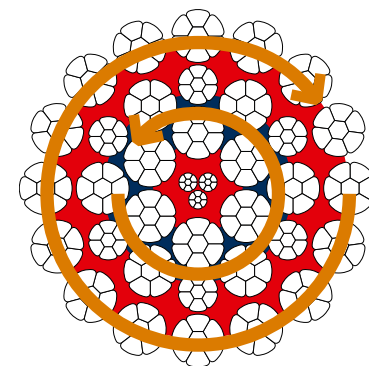
Lubrication is applied to the IWRC core during manufacture and is sealed in by the plastic layer for the lifetime of the rope. The plastic layer also ensures that contaminants are prevented from entering the rope core.

With the ever-increasing demand to mine at greater depths of wind, extensive research and development was undertaken to afford WireCo the ability to provide the end-user with a product that, can meet these demands, cost-effectively. The result was the design and development of StarPlast VMF, a significantly improved version of the StarPlast VM (already an unmatched and leading rope design at the time). Significant changes to the design include; replacement of the wire main core (WMC) by helically formed strands and coating of these formed strands with a plastic layer. The rope, therefore, is manufactured with two layers of plastic. This ensures all elements in the rope react in the same manner under load, and no single element is subjected to premature failure.



Starplast VM

Both the mass per meter and tensile breaking force are comparable with the StarPlast VM but, the design has significantly improved performance characteristics, for deeper lengths of wind and ensured that also the center core was stabilised effectively to match the fatigue performance of the outer strands



Starplast VM

The opposing directions of lay are made up of typically sixteen outer strands generating a moment in one direction, which is balanced by a total of nineteen strands creating the counteracting torque or moment. During the manufacture of the IWRC, a large number of strands are densely packed by parallel closing. The result is that the metallic cross-section of the IWRC is now considerably greater than that of the outer strands.

Equal stresses between the outer strands and the IWRC core is achieved by this design and process. The disadvantage of the IWRC strands having shorter lever arms, is compensated for by a greater metallic area in each strand and consequently by having greater force components. The greater number of the strands in the

IWRC, accounts for the rest. This design makes it possible to compensate the moments of the IWRC and the outer strands, for an extensive load spectrum. The high metallic area of the IWRC is made possible firstly, by compaction of the individual strands but also, by further compaction of the complete IWRC, after closing. This is a patented manufacturing process, registered by WireCo (US Patent No. 4454708).

As the torque and stresses are near equal, the residual moments are near equal, resulting in a torque factor, near-zero (rotation resistant). As a result, the typical torque related problems encountered in a Koepe winder head rope, are eliminated.

CASAR's StarPlast VMF combines both of the essential criteria; rotation and fatigue resistance but, also the magnitude in stresses present in the opposing lays of stranding is kept near equal, resulting in a very stable rope under all winding conditions, and no over-stressed elements in any of the opposing layers. The combined effect resulting in improved service life.

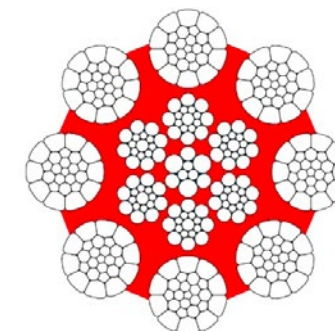
Where existing winding parameters or certain requirements are in place as to make the preferred rope designs not feasible, these requirements can be discussed with CASAR's engineering team, to allow for CASAR to quote for the optimum and most cost-effective solution.

WireCo CASAR- Multi-Stranded Ropes

The WireCo Casar speciality hoisting ropes deliver precisely engineered and custom designed solutions for each application.

Proprietary designs deliver record setting service life.

Lower torque designs and innovative wire arrangements require less maintenance and resist drum crushing, lowering cost of ownership and improving mine profitability.



Turboplast MD

Decades of global mining experience and on-site engineering support help enhance safety and further improve rope performance.

The following are key attributes of WireCo Multi-Stranded Ropes.

- Parallel lay ropes, where all wires and strands have the same lay length. The linear contact leads to an optimal stress distribution. Furthermore, the compacted parallel design leads to a higher fill factor and breaking strength.
- Plastic covered steel core, where the proportion of plastic to the steel components is thoroughly harmonized in order to fulfill the aspired rope geometry. A plastic coating with a constant thickness and quality is extruded around the steel core. A thermal after treatment just before the closing of the rope ensures that the outer strands are embedded in the plastic jacket, thus forming plastic edges, which separate the outer strands. This aids to prevent internal wire breaks, prevent metal to metal contact, stabilizes the rope structure during installation and operation, seals in the lubricant, keeps out water and abrasive elements, absorbs dynamic energy and offers resistance to many chemical substances.
- Compacted strands have a higher breaking load, a greater flexibility and better rope-to-rope contact conditions than comparable ropes made of conventional round strands. Because of the thicker outer wires and the smaller exposed area they are more resistant to abrasion and corrosion. The formation of negative impressions on drum grooves and sheaves, is significantly reduced and the rope life on multiple layer drums is optimized.
- Lubrication is applied during the manufacturing process. This ensures the rope is provided with ample protection against corrosion and it is meant to reduce the friction between the elements, which make up the ropes as well as the friction between rope and sheaves or drums.
- Production tolerances are kept to within a range of +0% to +4%. However, special tolerances or limited tolerance ranges can also be covered.
- Ropes provided are of good quality and free from any visible defect and of adequate strength. All ropes are

tensile tested to destruction at Casar's manufacturing facilities for which a certificate of conformance is issued.

- All WireCo manufacturing facilities are accredited in terms of ISO 9001: "Quality Systems—Model for Quality Assurance".
- Ropes are Magnetically Tested post production process, in order to confirm production consistency.

3. THE MOST COMMON CAUSES OF ROPE FAILURE – DRUM WINDERS

Casar mine winder ropes reduce winding rope ownership costs by offering ropes capable of operating for a significantly increased number of cycles when compared to traditional rope designs commonly available in the open market. In addition, Casar mine winder ropes are capable of increasing payload for the same diameter rope, through increased lifting efficiency and compacted strand designs.

Casar's mine winder ropes are typically costlier than standard mining ropes. The main reason for the increased cost is the significant difference in quality and design of the rope construction (including galvanising, compacted strands, and a plastic layer between the steel core and the outer strands). However, it must be noted that the prediction of the service life of a mine winder rope can never be determined accurately. All mine winder ropes have a finite useful service life and to ensure safe operation, mine winder ropes must be inspected and examined at regular intervals so that, the mine winder ropes are replaced well before failure. In present times, shaft engineers, need a rough estimation of the useful service life of mine winder ropes to compare value and to ensure ropes supplied, are fit for purpose. The mine winder rope(s) proposed by Casar for a given installation, are selected based upon the rope specifications as listed in the information provided by the end-user, following the necessary duty and rope life prediction calculations.

The topic of drum winder rope deterioration has been well documented in the past, including key effects such as tension, bending and torsion fatigue, as well as wear and plastic deformation associated with radial pressure and back-slip of the mine winder rope on the drum, due to changes in skip loading during the winding cycle. Numerous

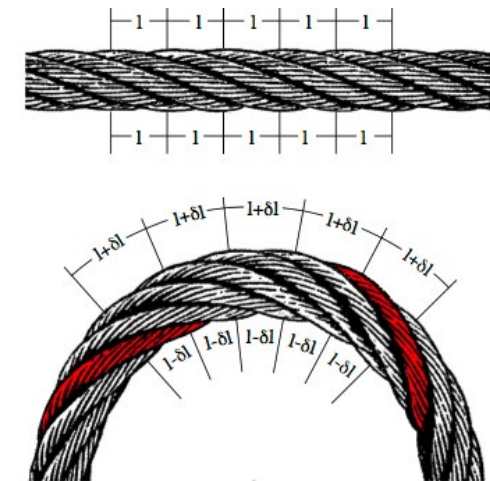
reports and articles have also been published, focusing on deterioration mechanisms of drum winder ropes discussing the effect of drum and head sheave sizes, number of rope layers, and the maximum dynamic rope load range on triangular stranded rope deterioration.

Key Influencing Factors

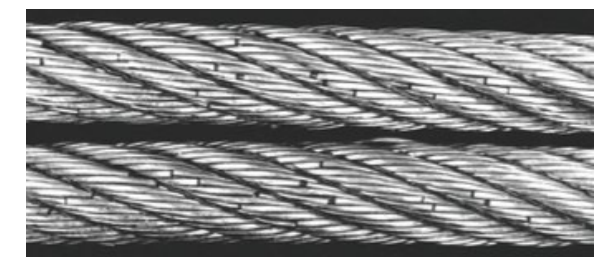
To better understand the reasons for the premature failure of mine winder ropes, especially at depth, the key influencing factors introduced into such a rope(s), requires analysis. Furthermore, the capability of the different mine winder rope construction(s), to withstand these factors and how their inherent deficiencies can be addressed, need to be considered. Findings of research done by Rebel and Vereet resulted in a method, whereby a number of influencing factors can be taken into account, to determine the expected rope deterioration rate. It must be noted that the primary degradation mechanism of mine winder ropes operating on parallel grooved multi-layer mine hoisting drums, is generally external wear and plastic deformation, at the half turn and layer cross-overs, towards the drum end of the ropes. In the paper presented by Rebel and Vereet, the influence that, (i) nominal radial crushing pressure on the drum, (ii) cyclic changes in rope load and (iii) sheave and winder acceleration issues, have on the rate of rope deterioration, need to be discussed as the same is considered in Wireco/Casar's rope selection. Further factors such as actual rope contact areas and geometry are considered in the analysis and recommendation(s) are made aligned to the optimum rope design and maintenance regime(s) for a given application. The main factors considered, resulting in the deterioration of deep level, non-rotation resistant, mine winder ropes, can be summarised as follows;

Fatigue

Wire rope bending fatigue is caused by running over sheaves or, on and off single layer drums. When a wire rope is bent around a sheave, each strand along its length comes to lie alternately on the outside of the bend, where it is lengthened, and on the inside, where it is shortened. Within a given strand, bending therefore causes lengthening (and tensile forces) in one place and – a few millimeters further on – shortening (and compression forces) in another. When bent around the same sheave, a rope with a helical arrangement of strands will therefore be subjected to much lower bending stress than a rope with a parallel, bundle-like arrangement of strands. This fundamental is why a closed wire rope, running over sheaves, will have a considerably improved useful service life, than a simple bundle of strands. When lifting a load, a radial force is generated in each strand, caused by the angle of lay against the rope axis.



Lengthening/shortening of individual strands



Fatigue cracks in a steel wire rope

A fatigue crack generally starts at the point of contact between the outer wires and the sheave or drum surface or at cross-over points, between individual rope wires. The fatigue crack then propagates, with the increasing number of cycles. With the increasing number of bending cycles, the fatigue crack will grow, reducing the load-bearing wire cross-section. Once the remaining wire cross-section is no longer able to carry its share of the load, the wire will fail, creating a fracture, which is perpendicular to the wire axis. Fatigue breaks occur more often on the inside of the bend (at the point of contact with the sheave) than on the outside of the bend (at the points of highest bending stresses). Wear or corrosion may contribute to the increased rate of fatigue crack formation and propagation. Good wire rope lubrication and re-lubrication during service will reduce the friction between the rope elements and therefore, improve steel wire rope fatigue resistance.

Bending Cycles over Sheaves

One bending cycle, for a given mine winder rope section, is defined as a change from a straight to a bent and back to a straight condition or, vice versa. Each time the mine winder rope section travels over a sheave, it is subjected to one bending cycle. During a typical lift, not every mine winder rope section will travel over the same number of sheaves and onto the drum. Therefore, along the mine winder rope length, rope fatigue is pronounced at those sections, which travel over the greatest number of sheaves, i.e. where it is subjected to the greatest number of bending cycles.

Where a mine winder rope section travels on and off a grooved single layer drum, the mine winder rope will undergo a change from a straight to a bent and back to a straight condition, i.e. according to the definition, it will also undergo one bending cycle. This bending cycle on a drum, is comparable to a bending cycle on a sheave, for a grooved single layer drum. Tests and practical experience have shown that, a bending cycle on a grooved single layer drum, will cause the same amount of rope fatigue as a bending cycle on a sheave, provided the line pulls and diameters are the same. In both instances, the rope will be bent around smooth, curved surfaces of the same geometry.

Bending Cycles over Multi-layer Drums

Where a mine winder rope section travels on and off a grooved multi-layer drum, the rope will also undergo a change from a straight to a bent and back to a straight condition, i.e. according to the definition, it will also undergo a bending cycle. However, the conditions are deemed different. Mine winder rope sections, spooling on the first layer, will be bent around a smooth drum surface however when the second layer is spooled on, the rope will be spooled over the first layer, compressing and damaging the upper rope crown by the second mine rope layer. Mine winder rope sections, spooling on the second and additional layers, will be damaged across the mine winder circumference: initially, the rope will be damaged during the contact with the neighbouring rope wrap, when entering the drum, then bent over a rough surface, created by the previous rope layer, leading to crown wire damage. The same section of rope is then damaged by the following wrap, due to fleet angle contact, leading to additional damage. Finally, the following rope layer will damage the rope section at the side or, if looking at a crossover zone, on the top of the rope. It is obvious that these sections of rope will be damaged, significantly more than by a single bend, on a single layer drum. Where the system has a multi-layer drum, each bend on the drum will be as much as 4 to 40 times as detrimental to useful rope life, compared to a single layer drum or a sheave. Spooling on a multi-layer drum, has the effect of constant hammering of one rough rope surface against another rough surface, of the same rope.

The Reverse Bending Cycle

Test comparison results(s) observed, of bend fatigue test(s) of simple bending cycles and bend fatigue tests with reverse bending cycles, have led to the presumption that a reverse bending cycle would damage a mine winder wire rope, twice as much as a simple bending cycle. Therefore, DIN 15020 stipulates that one reverse bending cycle should be counted as two simple bending cycles. Further investigations, under differing conditions, however, suggest that the damaging influence of the reverse bending cycle(s) vary under changes in the winding system. For example; the relative reduction in the useful service life of a wire, caused by a reverse bend cycle, is directly influenced

by sheave diameter(s) and tensile load(s).

Research by Casar confirms that a reverse bend cycle, in most instances, will influence mine winder ropes useful service life and the resultant damage factor effect, reducing useful service life by between 2 to 7 times, compared with a simple bending cycle system.

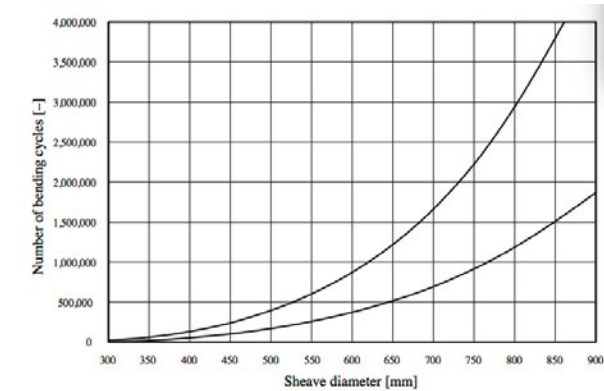
Tension-tension Stresses

A mine winder rope does not only fatigue as a result of bending cycles, running over sheaves or, drums, but also due to repeated changes in tensile load. Therefore, even an idle/static rope that never runs over a sheave, for instance, the suspension rope of a crane jib, has a finite useful service life, which is several times greater than the useful service life of the running ropes, of the same installation. Before and after mine winder rope(s) run over sheaves, change in tensile load occurs. Provided the number of bending cycles is great and the damage to the rope caused by the change(s) of the tensile load is at least one magnitude smaller than the damage caused by the bending cycles, the influence of the change(s) in tensile load, on the useful service life of a running mine winder rope can be negated.

A mine winder rope's resistance to fatigue increases with the increasing number of and decreasing diameter of the crown wires of a mine winder rope. This improvement is associated with a reduction in the mine winder rope's resistance to plastic wear, due to the smaller crown wire diameter(s). An increase in the number of strands within a mine winder rope significantly contributes to improving a mine winder rope's flexibility and resultantly, the mine winder rope's resistance to fatigue. Mine winder ropes endurance can be increased, by increasing the sheave and/or drum diameter or, by reducing the tensile load the rope is subjected to.

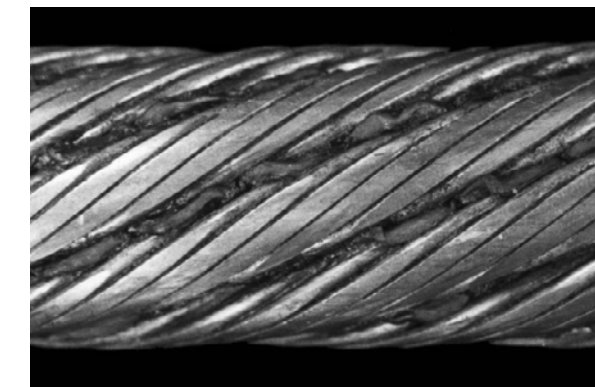
D:d Ratio

The influence of the D:d ratio (ratio; drum diameter to nominal rope diameter) contributing to the damage of a mine winder rope, suggests that, the mine winder rope damage increases considerably, with a decrease in D:d ratio. Where all operating parameters are unchanged, an increase in drum/sheave diameter of 25%, could result in a mine winder rope useful service life improvement, of up to 100%.



Effect of the drum/sheave diameter on mine winder rope useful service life

Wear



Abrasive/Mechanical wear

Mechanical wear, evident in mine winder rope(s), is the resultant removal of material, due to mechanical abrasion.

Mechanical wear against sheaves, drums, or neighbouring rope wraps, will result in the rope diameter initially reducing at an accelerated rate. Due to increasing mechanical wear, the bearing surface of the rope will increase, as the relatively small contact area on the surface of the outer wire is worn to expose a much larger contact surface and the rate of rope diameter reduction will diminish correspondingly. Provided the rate of diameter reduction, due to mechanical wear, is higher than the fatigue crack propagation rate, mine winder rope(s) will not develop fatigue wire breaks. Once the rate of diameter reduction diminishes, fatigue breaks appear. Mechanical wear must not be confused with plastic wear. Plastic wear is the deformation and displacement of material (with or without cross-sectional steel area loss). Lubrication plays

a significant role in reducing mechanical wear. Mechanical wear on multi-layer drums can be reduced by selecting a suitable mine winder rope architecture/design. For example; a mine winder rope with Lang's lay construction and compacted outer strands, will result in a mine winder rope with significantly improved mechanical wear characteristics. Compacted strands are initially stranded in the same way as conventional strands but, are subsequently drawn through a die tool or, in the case of Casar, compaction rollers, to reduce the strand's diameter, smoothen its surface and flatten the line of contact between individual wires.

Torque/Rope Spin

Mine winder rope(s) generate torque when subjected to a tensile load. The magnitude of the torque is a function of the helix geometry of the mine winder rope construction. In the instance of a drum winder, it has been established that the angle of lay, in the various mine winder rope elements, decreases linearly with the distance from the cage(s) but, does not vary during the wind. These variations increase with the depth of the winding installation.

To seek a condition of uniform torque in the presence of a significant tension gradient, geometric changes occur within the rope structure, which alters the torque characteristics. Measurements of such a mine winder hoist rope reveal that the lay length of the rope near the head sheave is longer than that of the as-manufactured mine winder rope, in contrast to the lay length of the mine winder rope adjacent to the skip, being shorter. The increase in lay length near the top of the shaft reduces the torque, while the decrease in lay length at the bottom of the shaft increases the torque. The extent to which lay length(s) change(s) occur, as the mine winder rope seeks a uniform torque condition, is a function of the length of the mine winder rope suspended in the shaft. The mine winder rope achieves these changes in lay length, through a rotation of the suspended section, notwithstanding rotation is prevented at each end. The maximum rotation occurs approximately at the mid-span, between the head sheave and the conveyance, once equilibrium is reached.

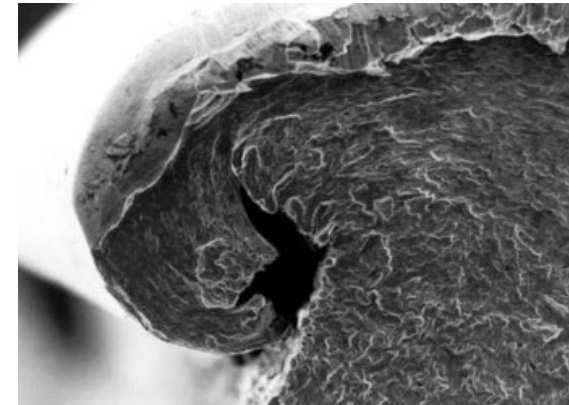
The term "equilibrium" refers to a condition of constant torque in the vertically suspended mine winder rope section. It is evident that, if the load in the mine winder

rope changes, then the induced torque will change. The suspended section of mine winder rope has no externally applied torque(s) therefore the torque is constant. This can only be achieved by a variation in twist along the length. The torsional behavior of Lang's lay mine winder rope(s), will limit their application in ultra-deep (2.500 m – 4.000 m) single lift shafts. However, these mine winder ropes have traditionally been used on the majority of drum winding systems, globally. Suspended mine winder rope length, diameter, manufactured lay length, deliberate loss in rotation, and rope weight per unit length, are regarded as being the most important factors relating to the torsional behavior of Lang's lay mine winder ropes.

The purpose of understanding a mine winder rope's behavior, as a result of induced torque, is to provide for appropriate/correct selection and design of a specific mine winder rope construction.

In the instance of a Blair Multi-Rope (BMR) double drum winder, two ropes are applied on either side of the conventional double drum machine/winder. The drum is divided into two sections/compartments so that, each mine winder rope is coiled on one half of the drum winder. Rope tension compensation can be achieved through a conveyance mounted compensating sheave, to which both mine winder ropes, in a compartment, are connected. Alternatively, the headgear sheaves can be mounted on interconnected hydraulic cylinders, to achieve the same effect. Maintaining equal pressure in the cylinders results in automatic adjustment for differences in mine winder rope length(s), ensuring equal mine winder rope tension(s). The main advantage is that 2 (two) mine winder ropes are applied to share the payload and subsequently, resulting in a decrease in mine winder rope diameter. Smaller diameter mine winder ropes are less prone to lay length changes than the larger diameter(s). However, care must be taken to limit the maximum number of layers on the drum, due to the typical narrower drum width, and the maximum allowable fleet angles.

The possible existence of a transition depth, for a particular mine winder rope construction and diameter, where a rope may no longer be suitable due to its torsional response, is well documented.



Plastic Deformation

In successful mine winder applications, the splice/termination end is shorter than a 20 percent decrease from nominal and none of the lay lengths exceeded a 70 percent increase at the sheave end. Short lay lengths, at the splice/termination end ($\leq 20\%$) results in that portion of the mine winder rope being prone to distortion, in the form of kinks and corkscrews. These distortions are the reason for immediate discard and it is accepted practice that, the splice/termination end lay length, should not be operated at more than 20 percent shortening from nominal. Casar mine winder rope(s) can be manufactured with a variable lay length, to compensate and subsequently reduce the induced torque and subsequent premature failure, of such a mine winder rope.

Contact Stresses on the Outer Surface of the Rope

Mine winder ropes show an even wear pattern around their circumference, which is a result of rotation due to variations in applied loads as well as dynamic effects. Each time a section of a mine winder rope passes over the sheave wheel and onto the winding drum, it does so with different contact points. The overall process of mine winder rope degradation results primarily from the interaction of plastic wear/deformation and subsequent fatigue of the crown wires. It is further complicated by the effects of torsional deformations, which are inevitable in any application involving long mine winder ropes, with fluctuating loads. With systems utilizing multi-layer spooling, the expected plastic deformation and subsequent fatigue failure are considered to be the main influencing factor consid-

ered in mine winder rope useful service life prediction, rope selection, and rope maintenance regime(s).

Radial Drum Crushing

This is specifically applicable to the deterioration of mine winder ropes on multi-layer drums. Of interest, are the effects of radial crushing pressure and cyclic changes in mine winder rope loads, on mine winder rope damage accumulation at the parallel grooved half turn and layer cross-over areas. It is known that no mine winder rope will be left in service long enough to reach a point where the mine winder rope will fail due to fatigue, caused singularly by bending cycles. There are several factors that lead to localised damage, typically at the cross-over regions and acceleration regions, where accelerated damage and deterioration occur. Thus, in all instances, the bending fatigue calculation(s) is of lesser importance, when compared to the effect of damage caused to the mine winder rope, by external mechanical elements.

Rope radial and axial loads on multi-layer drums can be determined more accurately where the rope radial stiffness and drum construction details are taken into account. Changes in mine winder rope geometry, during spooling (diameter and length) can decrease the overall radial pressure and tension experienced by the mine winder rope sections, already on the drum.

Other investigations have considered the exact effect(s) of mine winder rope maintenance practices, drum groove dimensions, groove pitching, and filler positions and sizes, on mine winder rope coiling behavior and damage in service for deep mining double drum and Blair multi-rope (BMR) hoists.

The method applied in Rebel's paper, to calculate the nominal radial crushing pressure on the drum (and hence bottom rope layer) is based on the more conservative approach and results in higher nominal crushing loads on the drum, as the method is devoid of dimensional change(s). Casar has developed a matrix to compare the influence of radial crushing, based on the findings presented by Rebel. The results obtained during these comparisons are taken into account during mine winder rope selection, considering the effect of cyclic rope load combined with the radial pressure(s). The selection process also considers the effect of increased mine winder rope surface area on mine winder rope damage, through the reducti-

on of radial crushing pressure. Operational experience has proven a direct correlation between the magnitude of the damage factor(s), the rate of rope deterioration, and required maintenance frequency. A higher magnitude of damage factor will result in reduced useful service life or, necessitate an increase in rope maintenance frequency requirement(s).

Calculation of Nominal Radial Crushing Pressure on the Drum

Applying the simple radial load summation approach and taking the worst case that all layers of the mine winder rope on the drum, are subjected to the same axial load, equal to the maximum mine winder rope load in the system, the equation(s) provides a result for the radial contact load per unit length and contact pressure, seen by the bottom rope layer on the winder drum, at the half turn cross-over regions (as per Equation 1).

The total radial rope load per unit length is:

$$R_{TOTAL} = R_1 + R_2 + R_3 + R_4 + 4 * w \quad (1)$$

where: w = rope weight per unit length (kN/m)

It can be shown (van Zyl 2000) that for small rope contact angles on the drum

$$\text{where: } R_n = F_n / r_n$$

R; = radial rope load per unit length (kN)

F; = axial rope load (kN)

rn = drum radius for the given rope layer (m)

n = rope layer number on the drum

Therefore, and assuming that F; is constant for all rope layers, i.e. simply maximum rope load F [kN], Equation (1) can be rewritten as:

$$R_{TOTAL} = F/(r+0 * d) + F/(r+ 1 * d) + F/(r+2 * d) + F/(r+3 * d) + \dots + F/(r+(n-1) * d) + n * w$$

Rearranging for n rope layers on the drum gives:

$$R_{TOTAL} = F * \sum_{i=1}^n [1/(r+(i-1)*d)] + n * w \quad (2)$$

where:

d = rope diameter (m)

From the total radial rope load per unit length, the total nominal pressure PTOTAL (as seen by the bottom rope layer and the drum) can be determined using Equation (2) assuming that the radial rope load is applied equally over the full projected contact area (as when calculating sheave nominal tread pressures)

$$P_{TOTAL} = (R_{TOTAL} * 1.000) / (1 * d) \quad (3)$$

The values obtained, will in all instances be significantly higher than the nominal tread pressure of 3.5 MPa that is recommended for headgear mounted sheaves for drum winder systems (Wainwright 1995). It is thus considered a more accurate method of comparing expected mine winder rope degradation rate(s), caused by radial pressure, than the traditional calculation(s), devoid of the effect of multiple layers on a winder drum. The wide variation in radial pressure on the drum(s), leads to different rates of deterioration of the mine winder ropes and it is, therefore, crucial to consider radial pressure issues, before selecting a mine winder rope for a particular drum winder installation. Different rope constructions will have varying resistance to high radial pressure loading at the drum cross-over points.

Influence of Cyclic Rope Load Combined with Radial Crushing

Studies have shown that it is the combination of radial pressure on the winder drum and relative axial movement of the mine winder rope cross-sections that lead to the plastic wear of the outer/crown wires and subsequent crown wire failure(s) at the half turn and layer crossover areas on the winder drum (Chaplin 1993). The concept of back-slip is particularly relevant to drum rock winders,

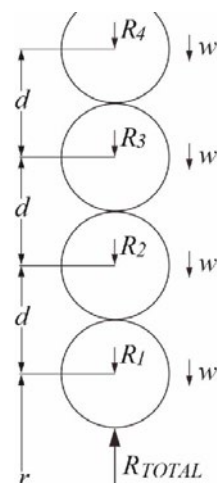


Figure 7: Rope geometry at the cross over(s)

where the ropes are wound onto the drums, under high tension and unwound, under a low tension i.e. hoisting a full skip up the shaft and then lowering an empty skip down the shaft. This results in the mine winder ropes slipping back on themselves as they leave the drum under a lower tension than initially wound on.

At the half-turn crossover areas, the mine winder rope cross-section(s) are directly above one another as depicted in Figure 7. This represents the worst possible contact condition(s) between adjacent mine winder rope surfaces. The dead turns on the drum are in a fixed rotational position and are therefore prone to damage at the half turn crossovers, more pronounced when not properly tensioned through doubling down with full skips or, cages. In contrast, the live turns, which are exposed to the same conditions, are not prone to the same severity of damage, due to the torsional response of the mine winder rope(s) in deep mine shafts. This torsional behavior leads to the continuous rotation of the live cross-sections and equal distribution of plastic wear around the live winder rope circumference(s). The dead turns do not rotate, thus impacted and worn in the same position. It is calculated that the damage to the dead turns, is 24 (twenty-four) times more concentrated than compared with the live rope section(s) (i.e. 15 degrees versus a 360-degree distribution of the damage). To be considered is that, differing mine winder rope construction(s) with differences in Modulus of Elasticity (less linear back-slip) and Torque factors (rotational differences), will result in differing levels of plastic and abrasive wear distribution in high-pressure areas.

Effect of Increased Rope Surface Area on Rope Damage

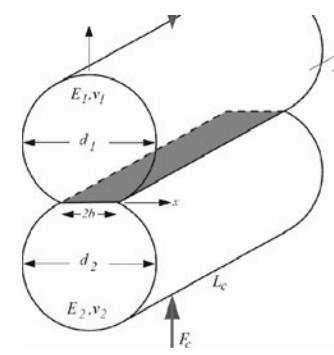


Figure 8: Cylinders in contact

Thus far, the total nominal pressure P_{TOTAL} (as experienced by the bottom mine winder rope layer and the drum) is determined using the projected area of 1 (one) meter length, multiplied by the mine winder nominal rope diameter. This approach is devoid of the different actual contact conditions that would apply for differing mine winder rope constructions. A detailed study on the surface condition and fatigue of mine winder ropes suggests that the strand contact areas vary significantly for differing mine winder rope constructions and also between new and worn mine winder rope(s), of the same construction (Nishioka 1966).

Applying principles derived from solid mechanics of elastic cylinders in contact and the radial contact load per unit length, like R_{TOTAL} from Equation (3), it is possible to calculate more accurate contact stresses between mine winder rope cross-sections on a multi-layer drum, at the half turn cross-over(s), for a given mine winder rope diameter.

For cylinders in contact as shown in Figure 8, the rectangular area of contact is 2*b*L (Shigley 1986) where b is the half-width of the contact area.

$$b = 2 * F_c * d_c * (1 - v_2) / (1 + v_2) * L_c * E$$

and;

V = V1 = V2 = 0.3 = Poisson's ratio

E = E1 = E2 = 150 GPa = assumed modulus of elasticity

d = d, = d2 = rope contact diameter, dependant on rope construction (m)

Lc = contacting cylinder length (m)

Fc = compressive load applied to the cylinders (N)

The maximum contact stress is defined as (Shigley 1986):

$$P_{MAX} = 2 * F_c / (n * b * L_c)$$

It is also necessary to consider what the contacting cylinder diameters, de, would be for differing mine winder rope construction(s) applied on mine winder systems. It is apparent from the difference in construction(s) between, for instance, a 6 stranded triangular strand rope and a compacted 8 strand, multi-stranded mine winder rope that, the effective contacting cylinder diameter, de, will be significantly different. The maximum contact stress

between differing mine winder rope constructions can subsequently be normalized and multiplied by the percentage payload, to determine an arbitrary damage factor K_{MAX} . It must be noted that the actual value is not the main concern however, the relative magnitude(s) is of importance.

The Effect of the Factor of Safety and Rope Layers

Given the nominal damage factor, $K_{NOMINAL}$, Rebel investigated how this factor changes for changes in mine winder rope factor of safety and rope layers on the drum, presuming the other parameters are fixed. It is evident from the data evaluated by Vereet and Rebel that, the nominal drum damage factor magnitude varies significantly for changes in design parameter(s). At a higher factor of safety, the effect of adding rope layers on the drum is not as significant as at the lower factors of safety, where each additional rope layer results in a significant increase in the damage factor.

Nominal Damage Factor

Having established that the in-service damage to mine winder ropes, is dependent on the nominal radial pressure on the drum and the simultaneous change(s) in mine winder rope loading that leads to back-slip, it is possible to define a nominal damage factor, $K_{NOMINAL}$, for the half turn and layer crossover regions. The nominal radial pressure, $PTOTAL$, is divided by the rope wire tensile grade to remove the units (Pa). The comparison of the relative magnitudes of the drum damage factor(s) is more important than the absolute values and gives an indication of the rope damage/deterioration that can be expected, between different rope installations.

Rebel determined that, if the mine winder rope's self-weight, w , is disregarded and the spooling on the drum is presumed to take place at the average diameter of all the layers, then the nominal damage factor, $K_{NOMINAL}$, can be approximated as follows:

$$= \frac{(20 * n * \text{Payload})}{(FoS * [(D:d)+n-l] * d^2 * T)}$$

where:

Payload = conveyance payload [kN]

FoS = minimum rope factor of safety for the winding system

D:d = drum to rope diameter ratio for the bottom rope layer on the drum

n = maximum number of layers on the drum

d = nominal diameter of the rope (mm)

T = Tensile grade of the rope (MPa)

This provides a method of calculating the damage factor, directly from the basic mine winder system parameters.

The combined effect of all the factors considered, results in a calculation based analysis, referred to as the "Radial Pressure Damage Analysis", which is used to assess the potential for a particular mine winder system to inflict damage on a particular mine winder rope. The higher the "Damage Factor", discussed in the aforementioned paragraphs, the greater the mine winder rope specification required or, the less useful service life to be expected. The same factor is applied in Casar's mine winder rope useful service life prediction model, as opposed to the normal sheave and drum tread pressures, resulting in a more accurate outcome.

4. THE MOST COMMON CAUSES OF ROPE FAILURE – FRICTION WINDERS

Given the inherent problems associated with the torsional behavior of Koepe winder head ropes, identified globally in the early nineteen sixties, rope construction(s) recommendations before that, did not discriminate between high torque and low torque (i.e. non-spin) Koepe winder head ropes. The inherent problems associated with the torsional behavior of Koepe winder head ropes were first realised in South Africa after the installation of the first deep shaft Koepe winders at around 1.350 meter depth of wind. Berry and Wainwright reviewed the application of Koepe winders, during the early nineteen sixties. Conventional 6 (six) stranded triangular Lang's lay ropes, selected as Koepe winder head ropes, for the 1.350 meter depth of wind, resulted in short service lives although, previously, they had performed well at shafts equipped with Koepe winders where the depth of wind(s) was less than 1000m. The initial sets of Koepe

winder head ropes at these depths had to be discarded prematurely due to distortion of strands, an outcome of excessive spinning (rotation) of the rope during normal hoisting operations. During the same period, similar problems were experienced at the West Driefontein Mine in South Africa (1.710-meter depth of wind). Following recommendations made by Berry and Wainwright, the ropes were replaced with rotation resistant ropes, and this eliminated the problem and behaved relatively well. Although, the exact reasons for the solution was not fully understood at the time, subsequent research and experience have brought valuable insight and understanding into the behavior of a Koepe winder head rope, and the conditions such a rope need to adapt to. Due to the system in essence being "in balance", irrespective of the position of the conveyances within the shaft, it was wrongly assumed that a given head rope is subjected to a constant load, the only variance being the payload. Also, in the early 1990's, in a study conducted by J Yuassoumis in South Africa, premature failures of Koepe winder head (rotation-resistant or "non-spin") ropes were attributed, to some extent to the release or built up of torque in the ropes. Release of torque, would loosen the outer and tighten the inner strands and vice versa, a built-up of torque. This upsets the stress distribution and results in premature rope failure.

To better understand the reasons for the premature failures, the key influencing factors introduced into a Koepe winder head ropes requires analysis. Furthermore, the capability of the different current winder rope construction(s) to withstand these factors and how their inherent deficiencies can be addressed, is reviewed and briefly presented in this document.

Key Influencing Factors

The main contributing factors to the degradation of a Koepe winder head rope can be summarised as follows;

Bending Fatigue

During winding over a sheave or drum, any rope is required to adjust to allow for the rope to be curved around a drum or a sheave. This causes relative movement between the elements, as well as a fluctuation in loads. Any rope installed on any given application has a finite rope life, and will eventually fail, irrespective of loading condi-

tions and/or depth. Where the applications are such that, no other influences exist that will affect rope life, the rope is expected to fail due to bending fatigue and as such, the life achieved can be considered the optimum for a given rope design. Different rope designs have different bending fatigue resistance levels, but where a certain rope design might be more resistant to bending fatigue, it might be more susceptible to other forms of deterioration. For instance, a rotation resistant rope will have circa ½ the bending fatigue life of a non-rotation resistant rope, but where rotations in a non-rotation rope are excessive, the rope might fail due to contact stresses between the strands and/or distortion of the strands, long before reaching even ½ bending fatigue life. For this reason, all factors and the effect thereof need to be considered, on any given rope design and for a specific application, to determine the most significant contributing factor towards rope failure, to aid in selecting the optimum rope design best suited to provide the optimum performance for the given operational parameters.

Complete Reversal of Loads

During normal winding, each length of rope is subjected to a complete reversal in applied load. A section of rope, located near the back end in one compartment and thus subjected to an increase in lay-length after loading, could be located near the front end and a subsequent decrease in lay-length after loading when the position of the conveyances in the shaft is reversed (opposite compartment).

Different Levels of Load/Torque

One of the main factors overlooked and only really identified in the '80s, as most engineers assume the winding system is in balance or very near to it. When considering a single section of the rope during a normal wind, the load experienced by this section of head rope will vary as the conveyance travels up or down the shaft. The reason is the constant increase in tail rope weight (conveyance traveling up the shaft) or vice versa. For instance, a section of head rope just above the conveyance will only be subjected to the conveyance mass and payload and very little tail rope weight at the loading station. Near the top of the shaft, that same section of rope will now still be subjected to all the loads listed above, as well as the added tail

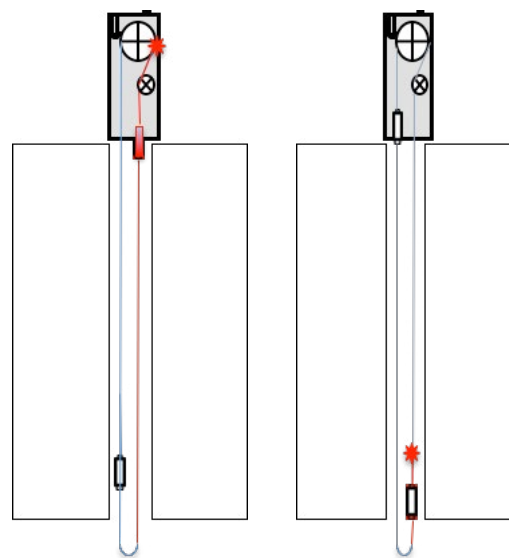
rope weight, which is continuously changing throughout the length of wind, therefore the rope head rope needs to adjust continuously to reach equilibrium. This variation in load induces rotation in the rope and can be observed during normal winding. It must also be noted here that, it goes without saying that irrespective of rope design, this variation in load and therefore rotation, can be reduced by decreasing the weight of the tail rope(s). Of course, there are limitations as the maximum out of balance weight to achieve an acceptable T1/T2 ratio. The maximum out of balance load the hoist is capable of lifting, also needs to be considered.

Sudden Changes in Load/Torque

To further complicate the load variations, the rope also needs to be able to adjust to a very different load within a very short time, as the rope passes over the drive sheave of the Koepe winder. In such an instance, the payload is immediately removed and the rope could also be subjected to much different suspended tail and head rope weights. This is further complicated when this section of the rope passing over the drive sheave is also subjected to acceleration or deceleration forces. This sudden reversal in loads results in elements in the rope having to continuously adjust rapidly to achieve an equilibrium in induced torque during winding. It should also be mentioned that the rope will also "creep" in relation to the drive sheave inserts, due to the differing loads in the opposing sides of the drive sheaves.

Load and Torque Increases with Depth of Wind

As the operating depth of a shaft increases, the suspended load, a function of the weight of the rope(s), increases proportionately. More importantly, the static load range becomes greater as the shaft gets deeper, as the suspended tail rope weight will always be negligible for any depth of wind, near shaft bottom, but increasingly more due to a longer tail rope near the surface, as the shaft gets deeper. As a result, differences between maximum and minimum rope loads increases (static load range), therefore resultant behavior and more specifically the number of rotations induced in the rope will increase.



Friction Driven – Contact Stresses/ Abrasion Cyclic Fatigue

Being a friction driven winder, the rope is subjected to contact stresses between the drive sheave and outside of the rope. Although not a major factor, this can cause abrasive wear and loss in material on the outside of the rope, and therefore a reduced rope life.

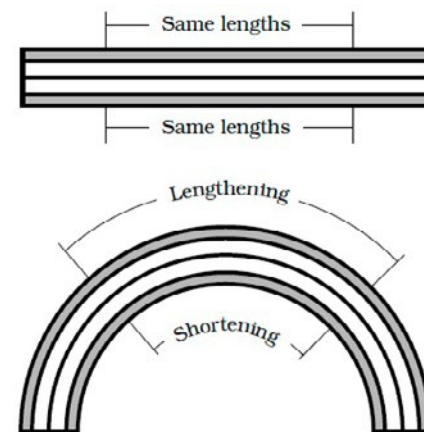
Corrosion

A Koepe rope is required to operate in harsh operational environments and corrosion should be a factor to consider, potentially contributing to premature failure. Both the surface finish and the lubrication regime of the rope can be adjusted to determine the most cost-effective means to achieve optimum service life.

The Effect of Variations in Load

From the contributing factors listed, it is observed that, the most significant influencing factor to consider, is the behavior of the rope when subjected to significant load variations. In short, the most obvious parameters that could influence rope life other than bending cycles, can be listed as:

- Sudden changes in load, due to cyclic winding and loading;
- Continuous changes in load, due to winding,
- Increased differences in maximum and minimum loads at greater depths of wind.

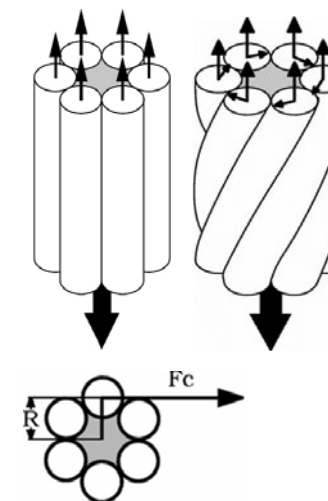


Now that the sources of possible fluctuations in rope loads have been identified, the effect of such fluctuations needs to be considered.

To allow for any rope to be able to be bent around a sheave or a drum, the strands in such a rope must be laid up in a helical pattern. However, with the advantage to be able to be bent around an object also comes a secondary effect.

When an axial load is applied to a rope, the following changes occur;

- The helical shape will create a tangential force at a distance from the neutral axis
- Tangential force at a distance results in torque
- The total of the products of the tangential forces and their distances from the neutral axis, determine the moment of a rope.



The helically formed strands of a wire rope under tensile load, tend to unwind. Therefore a rope specimen under tensile load with its two ends restricted from rotating, relative to each another, develops torque. The torque induced is a function of the tensile load applied to the rope and the relative rotation introduced between the two ends of the specimen, before the application of the tensile load

- The amount of torque and resultant moment will determine the amount of rotation that will result.
- This amount of rotation is directly proportional to rope life as the amount of rotation will determine the amount by which the elements within the rope have to adjust to, and the subsequent degradation of the elements within.

Further to the torque that results from loading and load variations, some other external conditions can also contribute to enhancing detrimental conditions;

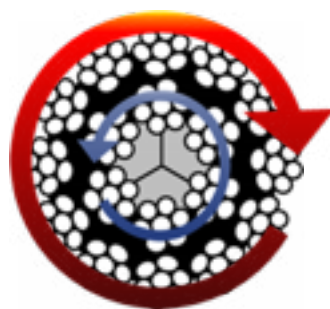
- Misalignment of sheaves and/or deflection sheaves
- Incorrect procedure during installation, related to reeving and/or serving.
- Incorrect groove diameters
- Differences in drum tread lengths

Load Sharing Mechanism in Multi-layer Traditional Non-spin Ropes

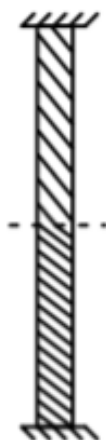
The fundamental principle of rotation-resistant ropes is that an independent wire rope core (IWRC) is covered with an outer strand layer, closed in the opposite direction. Torque will be equal in the opposing layers, once equilibrium is reached. The non-linear shape of the torque-tension curves of (traditional) non-spin or rotation resistant ropes, is a result of uneven distribution of the tensile load between inner and outer strands. With negative end rotation, the inner strands carry a greater proportion of the tensile load than the outer strands. The resulting torque is therefore negative. For positive end rotation, the outer strands will carry a greater proportion of the tensile load. The resulting torque is therefore positive. Once equilibrium is reached, torque in the opposing layers is equal, but not the stresses. The reason being, the difference in the cross-sectional steel area of the opposing layers and the differences in distances, from the neutral axis.

When considering the example herewith, 12 outer strands will counter 6 inner strands at double the radius of the inner strands. The sum of the moments will thus be;

$$(12 F_c \cdot 2R) - (6 F_c \cdot R) = 18F_c \cdot R$$



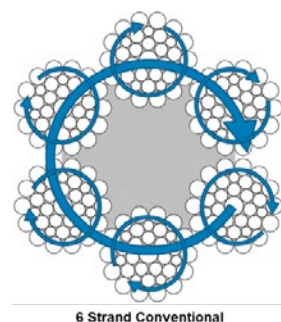
With such a high residual moment, significant rotation can be expected, even though the rope is classified as a rotation resistant rope. The use of these rotation-resistant or "non-spin" wire ropes, constructed with more than one layer of strands, wound in opposite directions, is the common practice on friction winders around the globe, serving deeper depth of wind shafts.



Summary of Attributes – Basic Rope Construction Spectrum

As a means to compare the different ropes installed on Koepe winders, the specific attributes of a Round Strand, Full Locked Coil and a 34 LR (Low Rotation) has been briefly explained.

6-Strand Conventional Design (6x36FC)

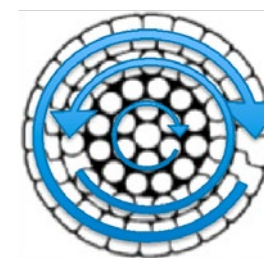


When torque is introduced (or let out), the following changes occur in a non-rotation resistant rope; Non-rotation resistant rope will rotate and find equilibrium, by lengthening and shortening of the lay length, along the length of rope (ends are fixed) Shortened lay length, causes oversteering and failure between strands, at greater depths of wind (low torque resistance, high spin factor), and possible distortion of the strands where the lay length is increased to the level that, the rope is unable to remain stable when wound over a drum or sheave. Due to the low steel density, significant stretch and variations in lay length (a direct result of induced rotations) is a limiting factor at deeper lengths of wind.

Full Locked Coil

The Full Locked Coil rotation resistant rope will find equilibrium, by shortening and lengthening of opposing layers of wire (high torque resistance, limited rotation). The sum of the forces and stresses in opposing layers will be equal if, the product of the steel cross-section and radii, is equal. Although this rope is considered a low rotational rope, the low torque factor is achieved by several single layers of wire, closed in the opposite direction, relative to each other. This results in many elements, constantly adjusting and scuffing against each other, whilst the rope

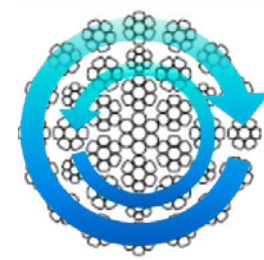
reaches equilibrium between the opposing layers (torque). From a rotation property, this rope is considered very effective but, it is well known that once the relative movement between opposing layers becomes compromised, the rope is unable to adjust to load variations, and waviness will result, which leads to premature failure. This phenomenon was reported and published by the UK Coal board in the 1960s and especially prevalent in rope diameters exceeding 42mm.



Full Locked Coil

34 Strand Low Rotation

The 34x7 to 24x17 rope designs will find equilibrium, by shortening and lengthening of the opposing layers (high torque resistance, low spin factor). Once reached, the torque in opposing layers will be equal but, not the stresses (different steel cross-section and radii). A significant improvement but induced rotation not as limited as the full lock coil. Stresses between individual strands will not be equal, due to different lay lengths of the individual strand(s) (unequal lay) and the moment not being zero (some positive rotation is still present at depth) High stresses between the opposing layers remain a significant factor, as positive rotation does allow for an increase in contact pressure between opposing layers.



34 Low Rotation

How do Koepe Head Ropes Fail?

To enable the design or selection of a suitable winding head rope for a Koepe winder, the typical modes of failure must be considered. As an outcome, the following attributes can be listed, as key, to be taken into account during the design of a Koepe Head Rope;

- The maximum variation in load range is determined by the depth of the shaft, the installed tail rope weight, and payload.
- This maximum variation is expressed as a percentage of the minimum breaking force of the head rope (static load range)
- The greater the static load range, the greater the torque induced and the greater the rotations induced.
- The magnitude of this static load range, and the resulting induced rotations for a given rope design, is directly proportional to rope life.
- Therefore, a higher breaking load and lighter tail ropes will improve the service life
- A non-rotation resistant rope offers a better fatigue service life up to a certain static load range (shaft depth)
- Where the static load range is such that it will result in significant rope rotations, a rotation resistant rope is required and at significant depth, a rope with the minimum amount of rotations will provide for the best possible service life
- For very deep shafts, the optimum rope life will be obtained if the rope has a near Zero/Low Torque Factor (Sum of moments = 0)
- It is recommended that the static load range be kept below 11.5% to ensure an acceptable rope life.

To further optimise rope performance the following needs to apply;

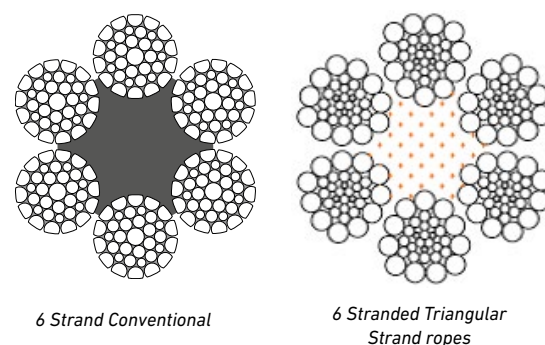
- Must have a High Tensile Strength, to achieve a higher Factor of Safety and therefore lower static load range as a percentage of the breaking strength.
- A High Breaking Force to Mass Ratio – Better Safety factor equates to better Rope Life
- Flexible – Resistant to Fatigue
- Resistant to External Contact Stresses (Tread pressures) and Abrasive Wear
- Maintain Integrity of Construction during Installation

- Resistant to Externally Induced Torque
- Shock Load Resistant
- Resistant to Stresses between Opposing Layers
- Resistant to Stresses within Individual Strands
- Torque and Rotation properties must remain uncompromised for the life of the rope
- Lubricated, lubrication to be maintained

As noted, premature failure of Koepe winder head ropes can be attributed for the most part, to the release of or torque built up in the ropes. The build-up of torque can overstress strands and also, the sudden release of the same torque can jeopardise strand stability. With a typical rotation resistant rope, the release of, or positive torque would loosen the outer strand and tighten the inner ones. This could upset the stress distribution and results in premature rope failure. An increase or negative torque will tighten the outer strands, causing an increase in contact pressures between opposing layers. The non-linear torque-tension curves were also identified as a reason why the stresses between the inner and outer strands were unbalanced. The varying levels of torque present in a Koepe winder head rope will manifest themselves, through rotation. This is proof that, the rope is continuously attempting to reach a state of equilibrium. With traditional non-spin ropes, these stresses can never become equal, due to the differences in effective cross-sectional steel area and the radii at which these forces are located in the rope. In a non-rotation resistant rope, distortion of the rope's geometry will occur, and excessive rotation and/or movement observed. Also, traditional non-spin ropes exhibit significant damage between the inner and outer strands, due to contact stresses between these elements and subsequent failure of the inner wires, these failures are common and difficult to detect during non-destructive testing.

5. TRADITIONAL ROPE SOLUTIONS

At present, the most common traditional rope designs installed on friction winders globally, can be summarised as follows (although there might be some exceptions, these are the most common);



6 Strand Conventional

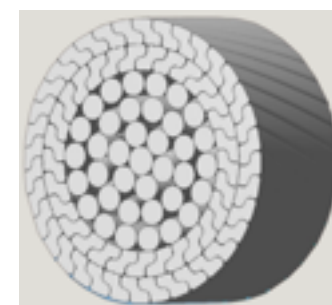
6 Stranded Triangular Strand ropes

Advantages

- Relatively cheap
- Readily available from most rope manufacturers
- Round stranded product can be in the compacted or non-compacted form
- Mediocre bending fatigue performance
- Fairly flexible and easy to handle
- No contact between opposing directions of lay

Disadvantages

- Construction not very stable
- Very low resistance to fatigue
- In certain designs, the length of lay within the strands will differ, resulting in high-stress contact points between wires.
- Will find equilibrium by significant rotation until opposing torque between the tightening of the outer strands near the front end, and loosening of the strands near the back end becomes equal.
- Very high spin factor/rotation
- Outer strands might fail due to distortion (back end) or high contact stresses between outer strands (near the front end)
- Acceptable rope life only achievable at shafts with very low static load ranges



Full Lock Coil

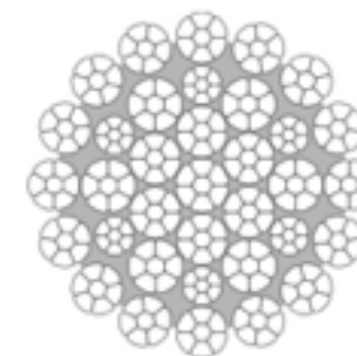
Advantages

- size for size they are of greater strength than stranded ropes, in the same tensile grade
- the smooth external surface provides greater resistance to wear, due to abrasion
- They will find equilibrium by shortening or lengthening of the opposing directions of lay
- they have excellent rotation resistant properties with minimal rotation (near zero)
- the elastic and permanent stretch is less than that of stranded ropes (can also be a disadvantage as drum groove tread lengths need very accurate maintenance)
- they can operate under higher radial pressures than any other rope construction(s);

Disadvantages

- Only one layer of wires, representing between 18% and 40% of the total length of all wire in the rope (depending upon the rope size and construction) is visible
- A significant number of layers closed in the opposite direction of lay, might be required to obtain the low torque factor/low rotation (depending on rope diameter)
- Locked Coil ropes are less flexible than other rope constructions. To ensure extended service, the rope should not be bent sharply and should work on drums and pulleys, where diameters are significantly larger than the minimum required for a multi-stranded rope.
- During service, Locked Coil ropes, generally over 42 mm diameter, may develop a wavy or spiral form instead of remaining straight, mainly caused by fretting corrosion.

- Locked Coil ropes should have no more layers of shaped wires than are necessary, as incremental layers further increase the probability of experiencing problems with waviness.
- They have a low breaking force to weight ratio
- Maintaining integrity of construction during installation is very difficult
- The close fitting wires leave little space for lubricant and post installation lubrication is not very effective



34 Low Rotation

Advantages

- Simple construction, readily available from most suppliers
- Strands can be compacted
- Will find equilibrium by shortening/lengthening of the opposing directions of lay
- Low spin factor (Positive)
- Good resistance against fatigue
- Fairly easy to maintain the integrity of construction during installation
- Post-installation lubrication effective for outer strands
- More stretch than a FLC, which allows for more tolerance on drum groove tread length maintenance

Disadvantages

- Strand design limited to 7(6/1) which will result in lower fatigue resistance for bigger diameter ropes
- High contact stresses between opposing layers when outer strands are tightened.
- High contact stresses between adjacent strands in the same directions of lay, when relevant lay lengths are shortened.

- Outer strands might become loose (birdcage) or the inner strands might protrude between the outer strands, where excessive rotation is experienced. (due to operating parameters or external induced rotation)
- The Center strand contains a single "King wire" which will have to be overstretched in areas along the rope where lay length is increased (straight line component inside a helix)
- Lubrication cannot be maintained for the life of rope, within the inner components

Conclusion

Although a friction winder system is designed to be nearly in balance, the load experienced by the friction head rope is constantly changing, due to the change in suspended tail rope length, as the conveyance travels within the shaft. For deeper lengths of wind premature failures of Koepe winder head ropes (rotation-resistant or "non-spin") can be attributed, to the release or built up of torque in the ropes, caused by rotation. This rotation is a function of the static load range, or largest variation in load experienced by the head ropes, and there is a direct correlation between the static load range and friction winder head rope life. Static load range is determined by the depth of wind, the breaking force/safety factor of the rope, the payload and the weight of the tail ropes. Release of torque, would loosen the outer and tighten the inner strands and a built-up of torque vice versa. This upsets the stress distribution and results in premature rope failure. Also, the non-linear torque-tension curves were identified as a reason why the stresses between the inner and outer strands were unbalanced. There is evidence that the rope is continuously attempting to reach a state of equilibrium, between the opposing directions of lay, by rotation of the opposing elements, until the opposing torque values are equal. Although the torque in the opposing layers will be equal after equilibrium is reached, the stresses and moments will not necessarily be.

Where the IWRC or inner strands are unable to match the moments present in the outer layer of strands, this will lead to overstressing of the IWRC and potentially cause the outer strands to go slack or, the core to "pop" from within the rope. This effect is worsened exponentially, as the diameter of a rope increases and where an increased

number of elements are required to limit rotation. In a full locked coil rope, with a low torque factor and limited spin, the linear and radial movements of these elements are excessive, due to the number of layers required for a given rope diameter, with instances where "waviness" can be expected, which is common for full locked coil ropes, with a greater diameter.

With traditional non-spin ropes, the torque induced stresses can never become equal, due to the differences in effective cross-sectional steel area and the radii at which these forces are located in the rope. Traditional non-spin ropes exhibit significant damage between the inner and outer strands, due to contact stresses between these elements and subsequent failure of the inner wires is common and difficult to detect during non-destructive testing.

The solution to the torque related problems will be a rope where the stresses between the outer strands and the IWRC can be kept equal or, as close to equal as possible and induced rotations kept to a minimum. Secondary to that, is the distribution of contact stresses within the rope elements and fatigue resistant properties.

6. KEY ROPE DESIGN ATTRIBUTES TO PREVENT MINE WINDER ROPE FAILURE

Drum Winders

Multi layered full steel mine winder ropes have enhanced advantages. Low compressibility and the compact structure of the mine winder rope guarantee geometric stability. The higher metallic area of full steel mine winder rope(s), results in a lower specific tension and as a result, lower stresses in individual wires, when subjected to the same loads. In addition, the increased number of outer

strands which are compacted and available in a number of parallel lay designs to optimise outer wire diameter are available. This effect underscores an enhanced useful mine winder rope service life. When considering the modes of failure, tried and tested solutions are readily available, to overcome these issues to a great extent, be it crushing, backslip or any other underlying cause;

Root Cause	Remedy
Contact stresses between layers	Plastic layer Same direction or equal lay
Contact stresses within individual strands	Equal lay length Adequate lubrication
Contact stresses between strands	Plastic layer Compacted strands Adequate support from core
Resistance to outer contact stresses	Compacted strands Bigger wires More strands
Resistance to induced torque	Correct lay length Flexibility
Integrity of construction during installation	Pre-forming Plastic impregnation
Resistance to fatigue	More strands/wires – flexibility Higher fill factor – less stress in components
Resistance to stress concentrations	Equal lay Bigger wires – more resistance to crushing
Resistance to overstressed components	Higher fill factor – less stress in components No "King Wire" within core
Resistance to corrosion	Protective film – Galvanising/Bezinal Plastic layer to seal in lubrication

Friction Winders

CASAR has for many years investigated the typical friction winder rope designs being applied, and spent a significant amount of resources and focus to identify and develop a remedy to the shortcomings of these rope designs, where it became clear that improvements could be made.

While it might not be exceptionally difficult to improve the performance of any design, the additional costs applicable in the manufacture of such a product, need to be such that the subsequent improvement in rope service life will still result in a more cost-effective solution. The available rope designs for all winding parameters can be optimised to ensure the most cost effective product is

supplied. Whether it be a system with lower static load ranges, where a non-rotation resistant rope with inherent improved resistance to fatigue, will outperform a rotation-resistant rope due to the inherent diminished resistance to fatigue, or be it for deeper lengths of wind, where static load range will increase significantly, Casar can provide the optimum solution and currently unmatched performance attributes by any other rope design available to the open market. There are also alternative rope solutions with characteristics that are a compromise between the attributes of the rope solutions mentioned, and typically selected for existing winders where specific weight and breaking forces need to be met.

Root Cause	Remedy
Excessive Rotation	Near zero torque factor Stressed within opposing layers near equal
Resistance to externally induced torque	More flexible. Numerous options of number of outer strands and wires to optimise rope performance
Contact stresses within individual strands	Equal lay length Adequate lubrication
Contact stresses between strands	Plastic layer Compacted strands Adequate support from core
Contact stresses between opposing layers	Compacted strands Bigger wires More strands
Contact stresses between outer wires and sheave/drum tread material	Compacted strands
Integrity of construction during installation	Plastic impregnation/strands locked in place
Resistance to fatigue	More strands/wires – flexibility Higher fill factor – less stress in components
Resistance to overstressed components	Higher fill factor – less stress in components No “King Wire” within core
Resistance to corrosion	Protective film – Galvanising/Bezinal Plastic layer to seal in lubrication

7. ROPE HANDLING AND MAINTENANCE

Rope Unloading:

Utmost care should be taken during the unloading of reels upon arrival at the mine. If the drum reels have not been equipped with suitable lifting attachment points, it is recommended steel bars be introduced through the holes in the rope reel flanges and these steel bars be suspended by suitable slings to a spreader beam to facilitate off-loading. Under no circumstances should these slings come into contact with the reel flanges. Damage to these flanges could affect the uncoiling of the rope during subsequent installation.



Rope Storage and Handling

Examine the mine winder rope(s) immediately after delivery to check its identification and condition and verify that, the mine winder rope is in accordance with the details on the Certificates and/or other relevant document(s).

Check the mine winder rope(s) diameter and examine any rope termination(s) to ensure that, they are compatible with the equipment or machinery to which they are to be fitted.

Supplied mine winder rope(s) should always be stored in a dry and well ventilated environment. WireCo recommends the use of suitable frames which will keep the reels clear of the ground. Special consideration should be given to the immediate surroundings to ensure the mine winder rope(s) are not exposed to elements which may be

harmful. If the mine winder rope(s) need to be stored outside, adequate steps should be taken to protect the rope from the elements.

Examine Mine winder rope(s) in storage periodically and when necessary, apply a suitable dressing, which is compatible with the manufacturing lubricant. Upon completion, re-wrap the mine winder rope(s) unless it is obvious that this will be detrimental to mine winder rope preservation. Failure to apply the correct dressing may render the original manufacturing lubricant ineffective and rope performance may be significantly affected. In addition, it is recommended that the rope be rotated through 180° at intervals not exceeding 6 (six) months, to prevent the excessive migration of lubricant within the rope.

Mine winder rope storage and handling (i.e. before installation) must always be in accordance with generally accepted practice and all reasonable efforts must be made to protect the ropes from mechanical and or environmental damage. Mine winder rope(s) must never be dragged over the ground during maintenance procedures. Each mine winder rope(s) reel must be properly covered to protect the rope against the weather and elements.

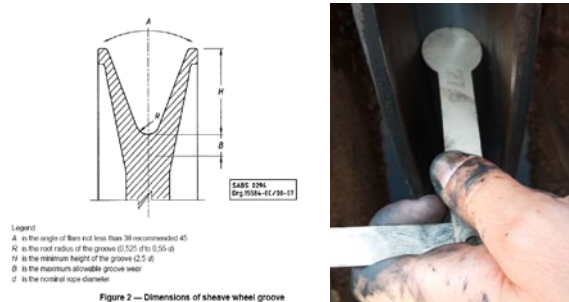
Pre-installation Checks

Sheaves

All sheave grooves, including doubling down sheaves, must be checked for proper surface finish and size in accordance with SANS 10294, „Code of practice for the performance, operation, testing and maintenance of drum winders relating to rope safety“, available on request from the SABS.

Sheave alignment, with respect to the winder drum, must be in accordance with SANS 10294. Fleeting angles between the rope and any sheave(s) must not exceed 1.50 for plain and 2.00 for grooved drums at any time, either during installation of the rope, maintenance or, permanent operation for conventional mine winder rope(s). Non-spin ropes require a fleeting angle less than 1.50.

Special care should be taken to ensure that, sheave groove diameter(s) are within acceptable limits. WireCo requires that, sheave(s) be cut prior to installation of new mine winder rope(s), to ensure that, no undue damage is introduced to the rope and to prevent torque build-up in the rope(s) which may lead to “waviness” and subsequent premature failure.



In accordance with SANS 10294 „The performance, operation, testing and maintenance of drum winders relating to rope safety“ a sheave groove diameter recommendation of between 1.05 and 1.10 times the nominal rope diameter is given. (Ref: SANS 10294, Page 12, Figure 2).

$$\varnothing \text{ MIN} = 1.05 \times d_{\text{nom}} \times 2 = + 5 \%$$

$$\varnothing \text{ Opt} = 1.075 \times d_{\text{nom}} \times 2 = + 7.5 \%$$

$$\varnothing \text{ MAX} = 1.10 \times d_{\text{nom}} \times 2 = + 10 \%$$

Drum Sleeves

Drum sleeve groove profiles must be inspected and the sleeves must be properly cleaned, eliminating sharp edges before the new WireCo mine winder ropes are installed. It is important that, the drum sleeve grooves conform to the SANS 10294 code, „The performance, operation, testing and maintenance of drum winders relating to rope safety“, Annex B recommendation, drum grooves to be 6.0% to 8.0% greater than the nominal mine winder rope diameter. Drum sleeve mounting bolts must not become loose at any point during the service life of the mine winder ropes. The bolts must be checked for tightness before new WireCo mine winder ropes are installed.

Hawse Hole

The hawse hole entrance must be properly maintained and clear of rough edges.

Risers

The drum risers must be properly secured and maintained.

Rope Terminations

Rope terminations must be made in accordance with the relevant regulations and standards

Rope Coiling

One layer spooling: For drums with one layer, the following applies:

right hand drum – left hand rope

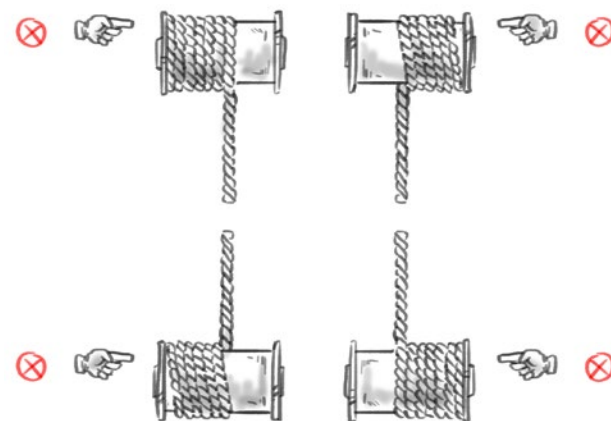
left hand drum – right hand rope

Multiple layer spooling: With multiple layer spooling, the direction of spooling changes from layer to layer. So the direction of lay of the rope would also have to be changed from layer to layer. Here, the direction of lay should be chosen for the layer which is working the most:

right hand layer – left hand rope

left hand layer – right hand rope

And here is how you determine the direction of the winding of the drum or reeving system: Place yourself at the fix point (X) of the rope on the drum (at the reeving system) and follow the turns of the rope with your finger.



Rope Installation

Rope Installation and Tensioning

Details of rope installation and rope tensioning procedures (e.g. doubling down) should be discussed and agreed with WireCo, before the procedure(s) are implemented. This is deemed a critical requirement. It includes the transfer of ropes from WireCo mine winder rope reels onto winder installation drums, in the case of Koepe installations, in order to conform to critical fleeting angels.

Handling and installation of the mine winder rope(s) is to be carried out in accordance with a detailed plan and should be supervised by a competent person.

Visual examination of the mine winder rope(s), to

ensure that no damage or obvious signs of deterioration, has taken place during storage or transportation to the installation site, is deemed to be critical.

When releasing the outboard end of the mine winder rope from a reel, same is required to be undertaken in a controlled manner. On release of the bindings and servings used for packaging, the mine winder rope is inclined to straighten itself from its previously radiused position. Unless controlled, this could result in a safety critical condition, which could cause injury to personnel, assigned to the task.

The new mine winder rope should be installed with adequate tension, especially where there is multi-layer coiling on the winder drum and it is not possible to tension the full length of rope subsequent to installation. This back tension arrangement should preferably be able to provide a tension equal to the normal working tension but, not less than half the normal working tension (the same tension as obtained during normal “doubling down” procedure(s), where the rope termination is secured to the shaft headgear and the conveyance loaded with a fully laden conveyance.). It is critical that, mine winder rope(s) are doubled down on multi-layer drum(s), with full skips or cages, after installation and after each back-end cut, to ensure proper tension on the dead turns on the drum(s). Doubling down should ideally be done to within ½ of a turn of the hawse holes but, at least to within one turn. When using a “doubling down” arrangement, the groove diameter of the doubling down sheave should be no less than 7.5% to 10.0% of the nominal rope diameter, and the d:D ratio no less than 1:32.

Under NO circumstances should torque be introduced into a new mine winder rope during installation. This will occur if the old mine winder rope is used to reeve the new mine winder rope into the system and the rope(s) are attached in a manner which will transfer the torque present in the old mine winder rope into the new rope or, if the sheaves are misaligned. The cause of any such torque should first be eliminated before installation. The use of a swivel that will eliminate the transfer of torque from the old to the new rope is highly recommended.

Mine winder ropes may never be dragged over the ground during installation or, during maintenance procedure(s).

Re-reeling of the ropes on-site, before installation, is not recommended. WireCo recommends that, the mine winder rope(s) are spooled directly onto the winder drum(s) from the reel(s), on which they were supplied.

During the manufacturing process, every mine winder rope is constructed with a preferred bending direction, which is determined during closing. When delivered to the end user, the mine winder rope is delivered in the same condition. It is deemed imperative that, the rope bends in the same direction when wound from the reel to the winder drum. If the mine winder rope is wound to the bottom of the winder drum (underlay), it should leave the drum from the bottom and must be installed in the same manner (top) to the overlay drum. Thus the ropes are always installed from bottom to bottom, and top to top. Should this procedure not be adhered to, the mine winder rope will twist back between the reel and winder drum, or later try to obtain its preferred position during normal service. In both cases, structural changes will occur, which could lead to premature discard.

Position the reel and stand such that, the fleet angle during installation, is limited to 1.5 degrees. If a loop forms in the mine winder rope ensure that, the loop does not tighten, to form a kink.

Monitor the mine winder rope(s) carefully as it is being pulled into the system and make sure that, the mine winder rope(s) is not obstructed by any part of the structure or, mechanism which may cause the rope to come free. Take particular care and note the manufacturer’s instructions when the rope is required to be cut. Apply secure servings on both sides of the cut mark. Ensure that, the length of serving is at least equal to 2 (two) mine winder rope diameters.

When terminating a mine winder rope end, with a wedge socket, ensure that, the mine winder rope tail cannot withdraw through the socket, by securing a clamp to the tail or, by following the manufacturer’s instructions. The loop back method uses a rope grip and the loop should be lashed to the live part of rope, by a soft wire serving or, tape, to prevent flexing of the rope in service. The method of looping back should not be used if there is a possibility of interference of the loop with the mechanism or structure. Failure to secure in accordance with instructions could lead to loss of the mine winder rope and/or injury.

When coiling a mine winder rope on a plain (or smooth) barrel drum, ensure that, each lap lies tightly against the preceding lap. The application of tension in the mine winder rope significantly assists in the coiling of the mine winder rope. Failure to correctly secure the mine winder rope end correctly is likely to lead to slackness, distortions, premature removal from service and a reduction in the breaking force of the mine winder rope.

Ensure that, any fittings such as clamps or fixtures are clean and undamaged before securing mine winder rope ends. Make sure that all fittings are secure, in accordance with the OEM's instruction manual or, manufacturer's instructions and take particular note of any specific safety requirements e.g. torque values (and frequency of any re-application of torque).

Check that, the new mine winder rope is spooling correctly on the winder drum and that, no slack or cross laps develop. If necessary, apply as much tension as possible to ensure tight and even coiling, especially on the first layer. Where multi-layer coiling is unavoidable, succeeding layers should coil evenly on the preceding layers of rope.

Running In

Rope running in procedures must be conducted in accordance with WireCo recommendations. Where possible, the following running-in procedure is recommended, to allow the ropes to settle in satisfactorily;

- 3 cycles $v = 2$ m/s after adjustment
- Examination of all rope connections
- 10 cycles = $\frac{1}{2}$ Speed No load = empty skip/conveyance
- 15 cycles = $\frac{1}{2}$ Speed $\frac{1}{2}$ Payload
- 15 cycles = $\frac{1}{2}$ Speed Full skip/Loaded conveyance (Licensed payload)
- 10 cycles = Max. speed Full skip/Loaded conveyance (Licensed payload)

Maintenance Related Issues

A mine winding rope comprises a number of mechanical elements, required to work in unison without any undue compromise of the integrity of any of the elements. For this reason, maintenance practices will be similar for all multi-layered spooled winders, irrespective of rope construction, duty (Man or Rock) or design of rope (six stranded triangular or multi-stranded high performance ropes).

Cutting of WireCo mine winder rope(s) with a blow torch, is strictly prohibited. WireCo recommends the use of a frame mounted cross-cut angle grinder.

Arc welding or flame cutting of a WireCo steel reel, while the new rope is on the reel, is strictly prohibited. If steel fittings need to be attached to the reels for rope changing procedure(s), the details and method of attachment needs to be agreed in advance between the mine and WireCo.

To prevent inadvertent damage, it is recommended that, the following point(s) be adhered to during normal operational maintenance;

- No spikes to be placed into the rope.
- No puncturing of the plastic in-lay layer may be allowed, at any time (applicable to multi-stranded high performance mine winder ropes).
- No inducing of spin/rotation or, spin/rotation out, of the mine winder rope(s), unless agreed to in advance with WireCo. Detachment of the mine winder rope(s) during normal re-making of end-termination(s), does not constitute inducing spin out however is deemed a normal operational procedure.
- During the re-making of end-terminations, care is to be applied, not to allow the rope to un-lay, as this may result in the fiber or steel core being overloaded. (Serving wire is to be applied prior to cutting of the front- ends)
- No „end for ending“ of TURBOPLAST, DUROPLAST multi-stranded high performance mine winder ropes or Triangular stranded ropes is permissible.
- Proper operation of rope load compensation systems for BMR winders must be maintained, at all times.
- Proper operation of conveyance holding devices (i.e. onto the shaft guides) when fitted, must be maintained, at all times.
- No slack rope is allowed under normal operating conditions.
- The mine must only use WireCo approved cleaning and degreasing agents, on WireCo mine winder rope(s). The use of inappropriate agents, e.g. trichloroethylene or paraffin/kerosene, can cause severe damage to the internal fiber or plastic in-lay core.

Lubrication

It is recommended that the mine apply CASAR recommended lubricants for in-service lubrication. The frequency of rope re-lubrication must be agreed between the mine and CASAR and should be applied according to good maintenance practice.

The method of applying rope lubrication is at the mine's discretion, however, CASAR recommend automatic lubrication systems which are based on lubrication dosing according to the number of cycles done by the rope.

Due to the primary lube, it is suggested to apply a suitable in service lubricant, which contains solvent that evaporates after application. It Builds a sticky but elastic layer on the rope surface. It's applicable with pressure device (Masto, Viper kit) or manually.

Application Amount:

Lubricant amount [in kg] = $(3.14 * \text{rope diameter [in m]} * \text{rope length [in m]} * \text{required lubricant amount [in kg je m}^2]) + \text{general loss (app. 10-20 \%)}$. It is calculated an optimal lubricant amount of $0.075 \text{ kg/m}^2 * 2$ (due to the containing amount of solvent 50%).

Due to the rope parts which are outside and due to the temperature, it is recommended a very small layer on the surface. Too much lubricant causes fling off in winter. In summer it can create dripping problems.

General Procedure:

The maintenance cycles depend on the area and usage of the ropes, working conditions at site (aggressive atmosphere, wet shaft etc.), climate and weather conditions. It has to be monitored from the mining operators. The rope should be cleaned and dry before starting the relubrication action.

- Monitoring (monthly)
- By facing rust spots on the rope surface or in between the gaps – starting cleaning and maintenance.
- The same cause by missing lubricant in or on the rope. Later one can extend the monitoring periods (quarterly)
- If still sufficient lubricant is on the rope. No need for relubrication. Maybe on certain parts of the rope only!
- Give time after lubrication to evaporate the solvent (e.g. during production break, low duty or out of service at night, weekend or maintenance break).

Principle: Less lubricant quantity by maintenance service but more regular continuous inspections.

For cleaning one can work with dry ice blasting system (coldjet), compressed air and brush system. The rope surface should be clean and dry. The product penetrates and sticks better on the metallic surface. The containing solvent allows the product to penetrate as well as possible into the rope.

Back-end Cuts

The number of cycles between successive back-ends on drum winders will be agreed to between the mine and WireCo. Determination of the permissible cycles between back-ends, is to be based on the operating history of the winder, rope NDT results and visual inspections of the turn and layer cross-over points, on the winder drum.

Integral to the "running-in" procedure, WireCo requires that, the first 2 (two) back-end cuts be performed at circa 7.500 (seven thousand five hundred) cycles. Subsequent back-end cuts will then be performed thereafter, based on the findings of the prior intervention(s), supported by NDT and visual examination(s), during the initial back-end cuts. the rope.

WireCo requires that, a minimum of 1/8th of the drum circumference be cut from the back-end during such an intervention(s), to ensure that, accumulated damage accrued at the cross over and layer cross overs, are effectively retarded from the scuffing and accelerated wear zones.

Tension on the back-end mine winder dead turns, must be maintained at a minimum of 50% of the maximum operating load, at all times after installation. This implies, doubling down with a full conveyance after every back-end cut. Note; at each back-end intervention, the mine winder rope must be twisted consistently in the winder rope's manufactured direction of lay, in the hawse hole, by at least 45°.

Front-end Cuts

The accumulated front-end cuts should not exceed the accumulated back-end cuts, at any given time. This is to prevent sections of the mine winder rope, exposed to accelerated wear and plastic deformation on the dead layers, from entering the "live" section of mine winder rope.

SUCCESS STORY: TELFER MINE

Special mining rope break records in Australia

The last 6 years saw a close cooperation between the rope manufacturer CASAR and the Telfer gold mine, based in the Pilbara region in the state of Western Australia. The Telfer mine is wholly owned by Newcrest Mining Limited. Gold and copper are extracted, above ground as well as underground. The copper and gold deposits were discovered in 1972, and mining began in 1977. In 2008 it was decided to increase the extraction capacities to over 6 million tons per year. This provided the basis for initial talks between Telfer and CASAR about the service life of the original ropes used on the floor hoisting machine and now the extraction capacities were due to increase too. The hoisting machine is a ground mounted friction winder which transports a payload of 34.5t at a speed of 16.25m/s from a depth of 1132m to the top.

The service life of the original ropes was maximally 95,000 cycles, corresponding to almost a year. The costs incurred by downtimes and the rope replacement after 95,000 cycles were immense and had to be drastically reduced to make extraction cost-effective. After a profound study of the site and application, CASAR decided to deploy a Starplast construction. This is a rotation-free rope construction made of compacted strands. A rope set consists of 4 hoist ropes, each with a length of 1360m and a rope diameter of 45mm.

CASAR succeeded to continuously increase the lifetime up to 210,000 cycles reached with the 3. version of Starplast. The result was overwhelming as the lifetime was more than double the previous figure. Furthermore, the ropes were in perfect condition even after these 210,000 cycles and only had to be discarded as a result of mechanical damage due to rockfall, not because of wear and tear. In addition, it was possible to virtually exclude undesired effects such as rope elongation and rope slipping on the drum, and wear on the inlays of the rope

discs was reduced to less than a quarter of the previous value. In particular the reduction of the elongation effect is really valued by Telfer as the usually necessary shortening of the ropes after occurrence of the setting effect is no longer necessary. At present the value of elongation for the 4. version of CASAR Starplast is less than 800mm.



CASAR and Telfer are confident that they are able to use the knowledge gained to further increase the service life to over 300,000 cycles. In this case the ropes would not have to be replaced for at least 3 years. This alone would represent major cost savings for the mine and also save a lot of time which could be used for other maintenance and repair work. It is estimated that at least 10 working days that would normally be needed to replace the rope could already be saved during the service life of the rope currently being used. The ropes currently in use already reached 170,000 cycles in March 2015 and are still in perfect condition. We are therefore confident of reaching the set goal. What Telfer particularly values in CASAR is that the efforts started in 2008 aimed at increasing the service life were back up throughout with advice and support. Not only were system measurements and destruction-free rope examinations carried out on site, but there were also intensive examinations of discarded rope pieces at CASAR, always focused on improving the product. Overall, this package of customised products coupled with outstanding expertise and technical support on-site has resulted in Telfer purchasing their hoist ropes exclusively from CASAR in Germany since 2009.

3 TIMES LONGER SERVICE LIFE

~3 year
300,000 cycles
CASAR Starplast
(goal)

~2 year
210,000 cycles
CASAR Starplast
(3rd version)

~1 year
95,000 cycles
original Ropes



Product specifications are subject to change without notice or obligation. The shown photographs, drawings or cross sections are only for illustrative purposes, the images can vary depending on requested diameter and current status of technical development.

The information supplied in this brochure is only a guideline for rope selection. Please contact us for any information or advice on the use of our ropes or if you have any doubt in selecting a rope for a specific application.

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