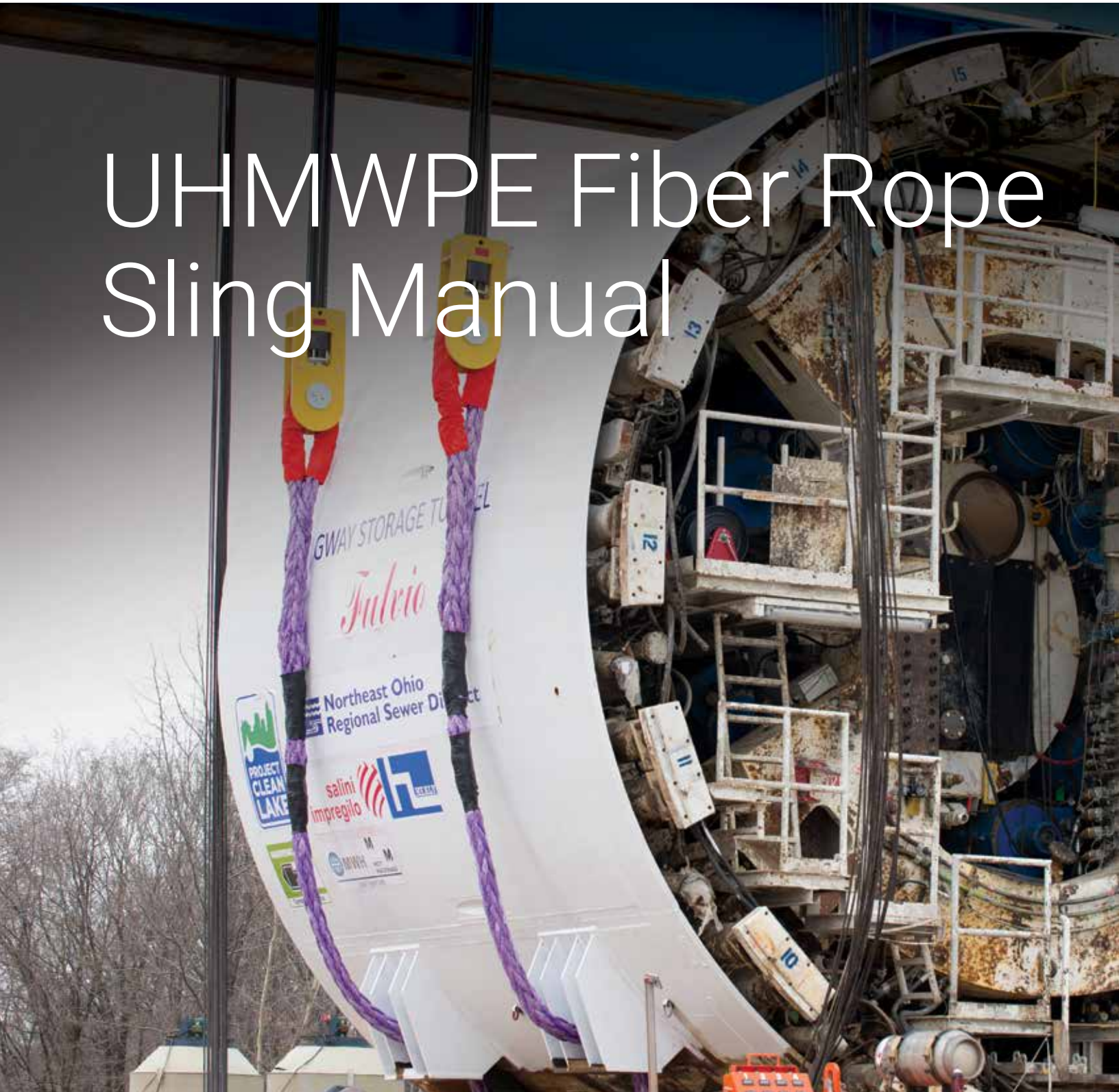


UHMWPE Fiber Rope Sling Manual



Detailed information for usage
of Cortland International fiber
rope lifting slings

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1a. Overview

Over the last decade synthetic high performance slings have become a critical load handling component, replacing steel wire rope. Modern, high strength synthetic fibers are remarkably durable and will not rust, corrode or produce broken/protruding wires. They are not affected by salt or fresh water, and wear points can be protected from abrasion, cutting and heat damage. Easy to inspect and repair, they are also soft on hands, offering a safer solution for riggers and expensive payloads.

The expertise that Cortland International has acquired in the use of high performance synthetic fibers hails back to the introduction of Kevlar® more than 30 years ago. The high strength, high modulus, low elongation, and light weight of modern high performance fibers are optimized by our manufacturing techniques and specialized constructions.

Synthetic fiber rope slings are different from wire rope slings. Unlike rigid metallic slings, synthetic fiber rope slings are significantly lighter weight and more flexible. They conform and tend to flatten against the surfaces they come in contact with, which decreases wear and tear on equipment.

We design, manufacture and supply synthetic fiber rope slings using both conventional and modern high performance fibers. Each sling is a product of base fiber strength, design, and production methods combined to achieve peak efficiency in sling strength; while being balanced to meet service life concerns.

Not all modern high performance synthetic fiber rope slings are designed and produced the same. While raw material choice, quality, construction, twist, braid levels, and coatings vary by manufacturer, Cortland is proudly innovative in our sling design and performance. Cortland fabricated ropes will provide weight, strength and product performance which cannot easily be compared with other manufacturers.

All fiber information and sling load charts herein, are backed by the extensive sling testing regimes and engineering expertise of Cortland.

Synthetic rope slings can offer many benefits over traditional steel rigging including:

- Lighter and easier to handle—1/7th the weight of steel
- Reduced risk of injury—no broken/protruding wires
- Reduced total costs
- No maintenance—no lubrication required
- Increased service life—no corrosion

When trying to meet the technical specifications of larger and more challenging lifts, synthetic rope sling solutions surpass traditional steel wire solutions through strength, weight, handling, and storage efficiencies.



Cortland International engineered rope slings were essential in completing a major municipal infrastructure program, Project Clean Lake

1b. Objective

The purpose of this document is to provide information and guidelines for the proper use of Cortland International synthetic fiber rope slings.

While not attempting to cover every possible factor in the usage of a fiber rope sling, this guide provides a basic foundation for correct choice and proper use. If the information provided within this document does not address or answer all product support needs, please contact Cortland International at contact@cortlandinternational.com.

Be advised: the most current and accurate content regarding rope use, inspection and retirement can be found at cortlandcompany.com or cortlandinternational.com. The information found at cortlandcompany.com or cortlandinternational.com may supersede the information in this and previous printed manuals.



Cortland International engineered synthetic fiber rope slings are used both offshore and on shore.

1c. Industry Standards

Fiber rope sling usage guidelines are referenced in several existing industry standards. This guide is specific to synthetic fiber rope slings and may offer guidance and direction in use and inspection not available in existing certification standards; e.g. ASME or DNVGL.

As reference documents the following standards have been utilized in this document:

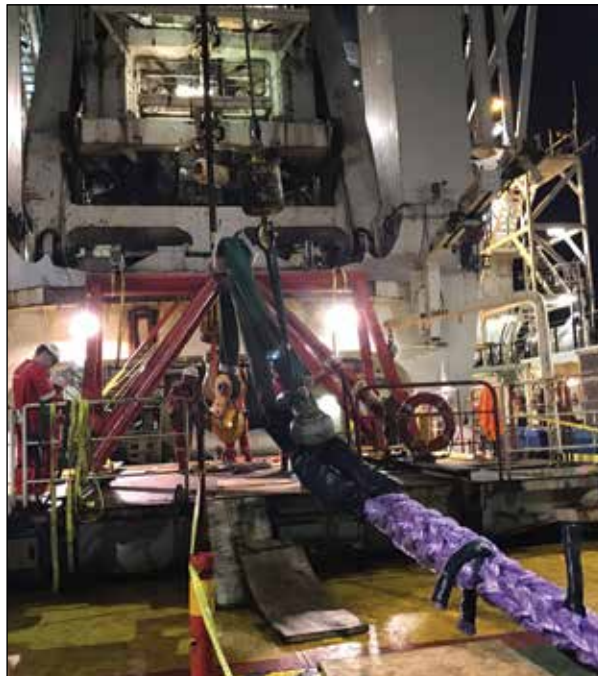
1. DNVGL-ST-N001 – Marine Operations and Marine Warranty, June 2016
2. ASME B30.9 – Safety standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks and Slings – 2018
3. BS EN 1492-4 – Textile Slings – Safety – Part 4: Lifting Slings for General Service Made from Natural and Man-Made Fibre Ropes – June 2009
4. IMCA LR009, M237 – The guidance on the selection, safe use and inspection of high performance fibre slings used for engineered lifts
5. The Cordage Institute International Guidelines
 - a. CI 2001-04 Fiber Rope Inspection and Retirement Criteria
 - b. CI 1500-02 V.2 May 2006 – Test Methods for Fiber Ropes
 - c. CI 1500A-15 May 2015 - Test Methods for Fiber Rope Physical Properties
 - d. CI 1500B-15 May 2015 - Test Methods for Fiber Rope Performance Properties
 - e. CI 1401-06 – Safer Use of Fiber Rope – Oct 2015



1d. Abbreviations

The following standard terms are important and/or have been used in this document.

Term	Description
CF	Configuration factor
CoG	Center of gravity
D	Diameter of interfacing hardware
d	Diameter of fiber rope sling
D:d	Bearing surface diameter with respect to sling nominal diameter
DF	Design Factor
EWL	Effective Working Length. Specified as the distance between Load Bearing Surfaces
FOS	Factor of Safety
HMPE	High Modulus Polyethylene
UHMWPE	Ultra-High Molecular Weight Polyethylene
MBL	Minimum Breaking Load
MTS	Minimum Tensile Strength
WLL	Working Load Limit = MBL / DF



1e. Glossary

ASME – The American Society of Mechanical Engineers.

Bearing Surface – The area of contact between two objects.

BS EN – A national standard adopted by the British Standards Institute (BSI) from a global standard.

Choke Point – A point where a sling in a choker hitch configuration passes through itself.

Choker Hitch – When using a choker hitch, one eye of the hitch is wrapped around the load and then passed through itself and then attached to the crane or hoist hook.

Coating – Additive applied to the rope which can affect the rope surface abrasion resistance, flex fatigue resistance, and/or surface coefficient of friction.

Cordage Institute – An international trade association of fiber rope manufacturers, their suppliers, and affiliated end-user organizations.

Core – Inner braid of a double braid rope; the core is contained within the cover braid.

Cycle length – The cycle length is the distance along the axis of the rope in which one strand makes one complete revolution around the circumference of the rope. A length of six consecutive picks running along the longitudinal axis of the final braid is the cycle length for a 12-strand rope.

D:d Ratio – Bearing surface diameter with respect to sling nominal diameter.

DNVGL – An international accredited registrar and classification society headquartered in Høvik, Norway.

Elongation – The measurement of stretch at a given load, expressed as a percentage of the original untensioned length.

Eye Splice – Method used to form an eye at the end of a rope.

Final braid – The overall rope is referred to as the final braid.

Grommet Sling – (or Endless Grommet or Endless Loop) – A fiber rope sling that is spliced into a loop.

HMPE – See UHMWPE

Hitch – How slings are configured to lift a load is called a hitch. Most lifts use one of three basic hitches: vertical, choker, basket.

IMCA – The International Marine Contractors Association.

Modulus – The modulus of a material describes how well it resists deformation. A material with a higher modulus is stiffer and has better resistance to deformation.

PPE – Personal Protective Equipment.

Picks – The point at which one strand running in one direction, crosses over or under a strand running in the opposite direction, is called a pick. Pick density is expressed as picks per unit length.

Qualified Person – A person who, by possession of a recognized degree or certificate of professional standing in an applicable field, or who, by extensive knowledge, training, and experience, has successfully demonstrated the ability to solve or resolve problems relating to the subject matter and work.

Primary braids – Each of the 12 strands comprising the final braid is a smaller 12-strand rope. The primary braids may also be defined in terms of picks and cycle length.

Primary braid strands – Each strand of the primary braids is a single twisted structure made up of fiber.

Shock Loading – A sudden or unexpected load that is imposed upon a system.

Splice – A method of terminating a rope by forming an eye or connecting two pieces of rope together.

Thimble – A ring or tear-drop shaped form, often of metal or plastic, that fits on the rope on the inside of an eye splice. It is used to prevent sharp bending of the rope at the top of the eye & to protect the inside of the eye from chafing or cutting.

UHMWPE – Ultra-high-molecular-weight polyethylene.

WLL – Working Load Limit (WLL) is the maximum working load specified by the manufacturer.

WLL (Rated Capacity) Tag – A tag on a sling that includes the name or trademark of manufacturer or if repaired, the entity performing repairs; code or stock number from the manufacturer; rated load for at least one hitch type and the angle upon which it is based; type of fiber material; and number of legs if more than one.

2a. Important Safety Instructions

Read all instructions carefully. Follow all recommended safety precautions to avoid personal injury as well as damage to the product and/or damage to other property. Cortland International [Cortland] cannot be responsible for any damage or injury from unsafe use, lack of maintenance or incorrect operation. Do not remove warning labels, tags, or decals. In the event any questions or concerns arise, contact Cortland or a local Cortland distributor for clarification.

All products supplied and manufactured by Cortland International are sold with the express understanding that the purchaser and user are thoroughly familiar with the safe and proper use and application of the product. The qualified person[1] and sling user has the responsibility for use and application, and must have sufficient training and knowledge of all applicable standards to responsibly use our products.

This manual follows a system of safety alert symbols, signal words and safety messages to warn the user of specific hazards. Failure to comply with these warnings could result in death or serious personal injury, as well as damage to the equipment or other property.



The **Safety Alert Symbol** appears throughout this manual. It is used to alert you to potential physical injury hazards. Pay close attention to Safety Alert Symbols and obey all safety messages that follow this symbol to avoid the possibility of death or serious personal injury. Safety Alert Symbols are used in conjunction with certain Signal Words that call attention to safety messages or property damage messages and designate a degree or level of hazard seriousness. The Signal Words used in this manual are DANGER, WARNING, CAUTION and NOTICE.



DANGER Indicates a hazardous situation that, if not avoided, **will** result in death or serious personal injury.



WARNING Indicates a hazardous situation that, if not avoided, **could** result in death or serious personal injury.



CAUTION Indicates a hazardous situation that, if not avoided, **could** result in minor or moderate personal injury.



NOTICE Indicates information considered important, but not hazard related (e.g. messages relating to property damage). Please note that the Safety Alert Symbol will **not** be used with this signal word.

Note: any and all components used for load handling activities, including but not limited to slings, fittings, hardware and sling protection may be referred to collectively as rigging.

[1] Qualified person: A person who, by possession of a recognized degree or certificate of professional standing in an applicable field, or who, by extensive knowledge, training, and experience, has successfully demonstrated the ability to solve or resolve problems relating to the subject matter and work.

General Safety Precautions



Failure to observe and comply with the following precautions will result in SERIOUS PERSONAL INJURY or DEATH. Property damage could also occur.

- Slings, rigging hardware and/or wear protection may fail if damaged, abused, misused, overloaded or improperly maintained resulting in SERIOUS PERSONAL INJURY or DEATH.
- All personnel must stand clear of lifted loads and never be under, on, or near suspended loads. Personnel must not stand in-line with or next to rigging under tension. An unplanned release of tension could strike personnel with deadly recoil force. Do not stand within recoil (snapback) area. Personnel must be alert to the potential for the sling and/or load to become snagged or hung-up.
- Slings shall not be shortened or lengthened by knotting or twisting and/or be joined by knotting.

2a. Important Safety Instructions *Cont.*

⚠ WARNING

Failure to observe and comply with the following precautions could result in SERIOUS PERSONAL INJURY or DEATH. Property damage could also occur.

- It is recommended that Cortland International rope sling users are properly trained in the inspection and proper use of the products. Failure to follow proper use, care and inspection criteria for rope slings could result in SEVERE PERSONAL INJURY or DEATH.
- Wear personal protective gear when handling synthetic rope slings. Safety equipment such as gloves, eye protection, non-skid safety shoes, hard hat, or hearing protection (used as appropriate) will reduce personal injuries.
- Do not drive or walk over slings or rigging.
- A Cortland rope sling must not be used if the original rated capacity tag is missing or is unreadable.
- The sling must be identified or labeled with the following information:
 - name or trademark of manufacturer, or if repaired, the entity performing repairs
 - code or stock number from the manufacturer
 - rated load for at least one hitch type and the angle upon which it is based
 - type of fiber material
 - number of legs, if more than one
- Ensure that rope slings have suitable characteristics for the type of load, hitch, and environment in which they will be used and that they are not used with loads in excess of the rated load capacities. Do not exceed the working load limit (WLL) rated capacity or shock load the rope sling.
- When using rope slings, careful consideration must be given to the effect of bending in the load handling operation. Potential strength reduction due to inadequate D:d ratios and the length of the eye are factors to be considered.
- If Cortland rope slings are to be used in a choker hitch configuration, it is mandatory that protection be used in the choke point.
- Do not bend rope slings around unprotected, damaging corners. Do not use over abrasive surfaces without sling protection. Avoid dragging rope slings over abrasive surfaces such as “non-skid” vessel decks during use, and from under the load. Make sure rope wear protection is in place or replaced when needed.
- Do not expose Cortland rope slings to temperatures above 158°F (70°C) for a period longer than 2 hours.
- Ensure that fittings are compatible with the mechanical and environmental requirements of the sling, have a rated load at least the same as the rope sling, have sufficient strength to sustain twice the rated load of the sling without visible permanent deformation, and have clean surfaces with no damaging edges.
- Thimbles shall have a minimum diameter at the bearing surface of at least two times the rope diameter. Use sheaves with a minimum of 8 times the rope diameter.
- Re-splicing of Cortland rope for load handling operations must be conducted by a qualified person.
- Re-spliced Cortland rope slings must be re-tagged with required identification information.
- A qualified person must be designated for every lift. It is the responsibility of this person to ensure that proper rigging practices are followed.
- Cortland rope slings must not be used for any fall prevention purpose. Only approved fall prevention products which are specifically rated and labeled for fall prevention must be used for fall arrest and/or fall prevention.

2a. Important Safety Instructions *Cont.*

CAUTION

Failure to observe and comply with the following precautions could result in minor or moderate personal injury. Property damage could also occur.

- Inspect rope slings for damage before each use. Inspection records must be maintained for individual rope slings. Inspections must cover the entire length of the sling including splices, end termination hardware, wear protection and fittings; and include those components that come into contact with the rope sling or have direct influence on the condition and overall sling performance. A system of inspection procedures and record-keeping is recommended. If a Cortland International rope sling has been idle or in storage for more than one year since the last periodic inspection, the sling must be thoroughly inspected by a qualified person before use.
- Use only rope slings in acceptable condition without cuts, pulled strands, or other damage. Do not use slings if there are areas of heat or compression damage, braid diameter size inconsistencies, stiff and flat areas on rope unable to be worked back into shape, glazed or melted fibers, or discoloration caused by unknown sources.
- Residual strength in a rope is subject to many considerations and a visual inspection can only provide a subjective estimate on retained strength.
- Rigging hardware, when employed, shall meet the requirements of ASME B30.26 and/or other standards used for lifting. Hooks, when employed, shall meet the requirements of ASME B30.10 and/or other standards used for lifting.
- Twist and rotation should be taken out of a rope sling before application.
- Slings, rigging hardware and wear protection should be stored in a clean, dry area, out of direct sunlight and/or any source of ultraviolet light and away from sources of extreme temperatures. The storage location should also be free of environmental and mechanical damage, corrosion, dirt and grit. If on a pallet, make sure other items which can damage or cut the sling are not stacked on top of the slings. Do not use or store near damaging chemicals.

NOTICE

- Cortland rope slings can be washed in warm or cold water to remove particulate matter without damage or loss of strength. It is recommended that only fresh water and mild detergents like dish soap be used. Washed slings should be air dried prior to storage. Slings must not be pressure-washed.

3a. UHMWPE Fiber vs Steel

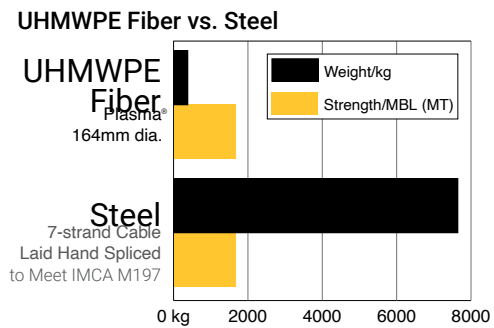
Over the last decade ultra high molecular weight polyethylene (UHMWPE) fiber ropes and slings have become a popular load handling component, replacing steel wire ropes.

Modern high strength synthetic fibers are remarkably durable and will not rust, or corrode. They are not affected by salt or fresh water, and wear points can be protected from abrasion, cutting and heat damage. They are also easy to inspect and repair.

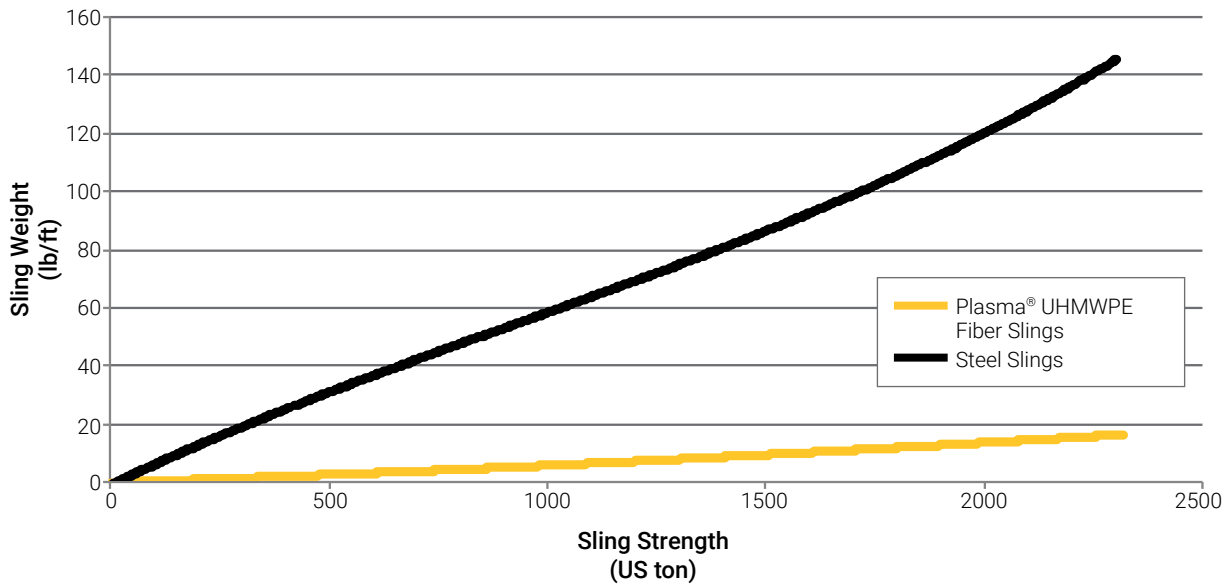
UHMWPE fiber slings offer significant reductions in rigging time, handling, transportation, and storage costs. They are 86% lighter than steel wire rope, offer superior flexibility, and are soft on hands offering a viable solution for riggers and expensive payloads.

Benefits of UHMWPE fiber vs. steel:

- Lighter and easier to handle
- Reduced risk of injury
- Remarkably durable, will not rust or corrode
- No broken/protruding wires
- Saves on transportation, storage, set-up
- Low maintenance
- Not affected by salt or freshwater
- Easy to inspect and splice



Steel vs. Plasma® UHMWPE Fiber Slings



3b. Selecting the Best Rope for your Application

There are many decisions to be made to ensure the correct rope is selected for each application. Before a rope sling is used in a load handling application, it is strongly recommended that a complete analysis be performed by a qualified person to determine the correct type and size of sling.

Each combination of rope material and construction has its performance advantages and disadvantages, and the selection of a rope always involves compromises based on the type of service.

Not all modern high performance synthetic fiber ropes are designed and produced the same; raw material choice, quality, construction, and coatings vary by manufacturer. Cortland International is an innovator in the design and performance of ropes. Cortland fiber rope slings provide unique, strength and product performance characteristics when compared to with other rope manufacturers.

Cortland designs and manufactures synthetic fiber braided ropes using both modern high modulus and conventional fibers. Each rope is a product of base fiber strength, design, and production methods combined to achieve peak efficiency in rope strength, yet balanced to meet service life conditions such as tension fatigue resistance and flexibility.

Fiber rope sling performance is dependent on three variables:

- Fiber selection
- Rope design and construction
- Finished sling configuration



3b. Fiber Selection

The base fiber is the most important choice in the design of a fiber rope sling. Below is a list of common synthetic fibers used in the construction of synthetic fiber ropes, and some known benefits of each.

Currently there are essentially two categories of synthetic fibers used in the manufacturing of synthetic rope. The first category is commodity fibers, which are typically lower in cost and higher in elongation. The second category is high performance fibers, which typically carry a higher price point and offer higher strengths and higher moduli.

Commodity

- Polyamide (Nylon)
- Polyester (Dacron®)

High Performance

- Aramid (Technora®, Kevlar®, Twaron®)
- LCP (Vectran®)
- PBO (Zylon®)
- Blends (BOB®)
- UHMWPE (Spectra®, Dyneema®, etc.)

Rope Material	Material Brand Names	Tenacity (gpd)	Specific Gravity	Water Absorption	Resistance to Sunlight	Elongation	Abrasion Resistance	Creep Resistance	Melting Point (°C)
Polyamide	Nylon	7.5–10.5	1.14	2–6%	Moderate	Very High	Very Good	Good	212
Polyester	Dacron	7–10	1.38	None	Very Good	High	Excellent	Very Good	250
Liquid Crystal Polymer (LCP)	Vectran	22–27	1.41	None	Good	Low	Very Good	Excellent	330
Aramid	Technora Kevlar Twaron	18–29	1.39– 1.45	3–7%	Moderate	Low	Good	Very Good	500
UHMWPE	Spectra, Dyneema	25–39	0.97	None	Good	Low	Excellent	Fair	140
Polybenzoxazole (PBO)	Zylon	42	1.54	2%	Poor	Very Low	Fair	Excellent	650

While Cortland International does manufacture fiber rope slings from other modern synthetic fiber materials such as Technora® (Aramid), Vectran® (LCP), Polyester and Nylon (Polyamide), the most popular fiber used for fiber rope slings is Ultra-High Molecular Weight Polyethylene (UHMWPE).

Polyamides (e.g. Nylon)

Polyamides are conventional fibers with moderate strength and good elongation properties. They are lighter and more elastic than polyester. However, they will absorb water and lose strength when wet.

Polyesters (e.g. Dacron)

Polyesters are conventional fibers with moderate strength and good elongation properties. They do not lose strength in water and have improved abrasion resistance. However, they are heavier and less elastic than Polyamides.

Aramids (e.g. Technora, Kevlar, Twaron)

Aramids are high-performance fibers specialized for elevated temperature applications. They have an extremely high melting point and great creep resistance even at elevated temperatures. However, they are heavier and have less abrasion resistance than UHMWPE.

Liquid-Crystal Polymers (e.g. Vectran)

LCPs are high-performance fibers specialized for creep applications. They have the best creep resistance of any fiber. Their abrasion resistance is somewhat better than the aramid family, but still not as good as UHMWPE.

3b. Fiber Selection *Cont.*

Polyphenylene Benzobisoxazole (Zylon®)

PBO is an extreme high-performance fiber. It has the highest strength and stiffness of any synthetic fiber, as well as the highest melting point and excellent creep resistance. However, it degrades rapidly in both water and sunlight, and is several more times expensive than other fibers.

Blends (e.g. BOB®)

Blends of two or more fibers are possible that can provide the benefits of each.

UHMWPE (e.g. Spectra or Dyneema®)

UHMWPE are the fibers of choice for most applications. They have some of the highest strength-to-weight ratio of any fiber, and the best abrasion resistance and chemical resistance of any fiber. They are even light enough to float in water. However, they have lower creep and thermal resistance than aramids and LCPs.



3b. Physical Properties of UHMWPE

UHMWPE fiber is light weight, high strength, and the only high performance fiber that floats on water. UHMWPE fiber provides greater handling, safety and long term cost savings.

Features and benefits of UHMWPE compared to other fibers:

- Highest strength to weight ratio (excluding PBO)
- Highest abrasion resistance
- Excellent dynamic toughness—i.e, tension fatigue resistance
- Very low elongation (~3% at break)
- Excellent flex/bending fatigue resistance
- Resistant to chemicals
- Specific gravity less than 1.0

Term	Property	UHMWPE
Strength	Wet strength compared to dry strength	100%
	Shock load absorption ability	Excellent
Weight	Specific gravity	0.98
	Ability to float	Yes
Elongation	Percent at break	2.5–3.5%
Creep	Extension under sustained load	Moderate
Effects of Moisture	Water absorption of individual fibers	None
	Degradation effect of fresh or salt water	None
	Resistance to rot and marine organisms	Excellent
Environmental Resistance	Fiber resistance to UV in sunlight	Poor
	Rope resistance to UV in sunlight	Good (above 12mm)
Rope Abrasion Resistance	Surface	Excellent
	Internal	Excellent
Coefficient of Friction	Resistance to slip or slide (on steel)	0.09 – 0.12
Thermal Properties	Critical temperature working limit*	150°F / 65°C
	Melting temperature	297°F / 150°C
Chemical Resistance	Effect of acids	Very resistant
	Effect of alkalis	Very resistant
	Effect of organic solvents	Soluble in chlorinated hydrocarbons

* Critical temperature is defined as the temperature at which the strength and elongation properties of the fiber begin to change irreversibly.

Specific Gravity

The specific gravity of UHMWPE is about 0.98. This is less than water, meaning the material is buoyant in fresh or salt water. For comparison, steel has a specific gravity of approximately 7.8. Fiber rope slings can equal or exceed the tensile strengths of steel wire ropes of equal size, at 1/7th their weight.

UV Resistance

The chemical makeup of all UHMWPE fibers regardless of type or manufacturer is the same, therefore all UHMWPE have very similar UV resistance. While the strength loss of UHMWPE associated to UV exposure has been documented to be in excess of 50% in some cases, depending on test conditions, it has been found that filaments of UHMWPE are self-masking.

In a rope structure comprised of many filaments arranged in a circular structure, only the very outer layer of filaments will be exposed to UV as the UV rays are not able to penetrate the layers beneath. As such, UV is less of a concern with UHMWPE ropes or rope slings of large diameters, or slings outfitted with wear protection or a jacket.

Additionally, a polyurethane coating on UHMWPE ropes or rope slings will help block UV rays.

3b. Physical Properties of UHMWPE *Cont.*

Creep

Creep is the irreversible elongation of a rope caused by constant loading. Ropes experiencing creep often retain relatively high breaking strengths until they are very close to failure; thus the need to check for operating conditions that may cause excessive creep. When used at appropriate WLL and temperature, UHMWPE will exhibit negligible creep elongation over the normal course of operations.

The risk for a rope creeping can be simplified into “The Three Ts”: tension, temperature, and time. Any operating conditions that involve high loading, elevated temperatures, or long durations will increase the elongation due to creep.

Abrasion Resistance

UHMWPE shows better abrasion resistance in comparison to other high performance synthetic fibers. This is in part due to the coefficient of friction of the fiber being relatively low, or slippery, which allows the fibers to move easily relative to one another, without damaging themselves. This low “self-abrasion” contributes to the robustness and longevity of UHMWPE compared to other fibers.

⚠ WARNING Temperature Resistance

UHMWPE ropes begin to irreversibly lose strength above approximately 65°C/150°F. Ropes made of UHMWPE must not be used when ambient or contact temperatures are expected to exceed 65°C. UHMWPE must not be stored at or otherwise exposed to temperatures exceeding 70°C/160°F for periods longer than 2 hours. Additionally, UHMWPE ropes must never be exposed to temperatures exceeding 130°C/265°F even for brief periods of time.

UHMWPE fiber ropes exhibit no loss of strength in cold environments. In fact, synthetic ropes gain strength at extremely low temperatures. Ice, however, must be removed from slings before usage.



3b. Chemical Exposure

UHMWPE fiber is impervious to most common chemicals, but degradation is subject to time of exposure, concentration of chemical, temperature and overall conditions. Chemically active environments can affect the strength of synthetic fiber rope slings in varying degrees from moderate to total degradation. See general guidance below, but contact Cortland International if the load handling sling will be used in a potentially damaging chemical environment.

Resistance to Chemical Immersion

	UHMWPE	
	6 Mos.	2 Yrs.
Seawater	Safe	Safe
Hydraulic Fluid	Safe	Safe
Kerosene	Safe	Safe
10% Detergent Solution	Safe	Safe
Gasoline	Safe	Safe
Toluene	Safe	Moderate
Glacial Acetic Acid	Safe	Safe
1M Hydrochloric Acid	Safe	Safe
5M Sodium Hydroxide	Safe	Safe
Ammonium Hydroxide (29%)	Safe	Safe
Perchloroethylene	Safe	Safe
Clorox Bleach	Fair	Do Not Use
Hypophosphite Solution (10%)	Safe	No Data
Nitric Acid	Moderate	No Data
Sulfuric Acid	Resistant	No Data
Phosphoric Acid	Moderate	No Data

3c. Rope Design and Construction

Rope performance can be tailored based on the construction, twist, and braid level. Cortland International manufactures rope with different constructions, mainly parallel, double braid, 8-strand, 12-strand and 12x12.

Strength, elongation and durability can be further impacted by the rope construction. Our 12-strand and 12x12 design considers all three variables and produces a balanced braid that optimizes each one of these considerations. If UHMWPE has been selected as the right fiber for the application, likely 12-strand or 12x12 is the optimal rope design to produce the best load handling sling.

	12-Strand	12x12	Double Braid	Wire Lay	Parallel Filament	3 Strand
Strength	Fair	Fair	Good	Good	Excellent	Poor
Modulus	Fair	Fair	Good	Good	Excellent	Poor
Durability	Good	Excellent	Good	Fair	Good	Poor
Inspectability	Good	Excellent	Poor	Fair	Poor	Fair
Spliceability	Good	Excellent	Poor	Fair	Poor	Good
Bending Performance	Good	Good	Fair	Excellent	Poor	Fair
Twist Tolerance	Good	Good	Fair	Bad	Bad	Bad

The strength, elongation, torque, inspectability and splice-ability attributes of 12-strand constructions make it the recommended variant for general purpose slings. The 12-strand design is tailored by way of twist level and braid angle to provide optimized strength and abrasion resistance.

The optimal construction for high performance fibers has proven to be a 12-strand design for many reasons:

- Strength: Moderate to high—size for size steel replacement
- Elongation: Low to moderate, similar to steel
- Torque: Zero rotation under load
- Inspectable / repairable
- Splice-ability
- Flexibility: Good to excellent

Our UHMWPE fiber rope slings are manufactured in a torque-free braided rope construction; either as a 12x1 or a 12x12 strand construction.

3c. Rope Design and Construction *Cont.*



UHMWPE 12-Strand, manufactured up to 1-1/2" (36mm)



UHMWPE 12x12 Strand, manufactured 1-1/2" (36mm) and above

Plasma®—The First, and Still the Best

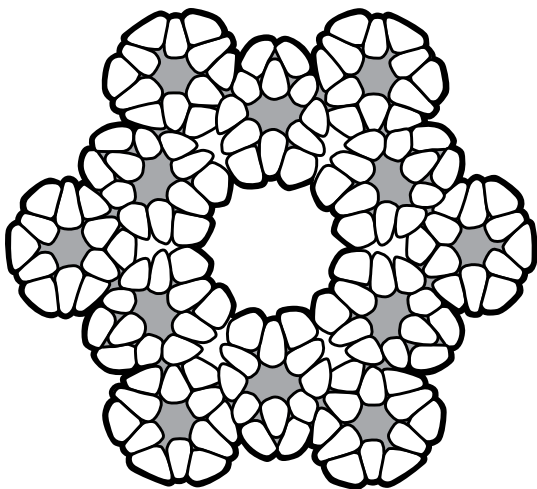
Plasma® 12-Strand and 12x12 ropes from Cortland International are the culmination of 25 years of engineering expertise in the HMPE industry. Our dedication to providing customers with industry-leading synthetic line is and always has been the goal. Our continued innovation and unwavering desire are to provide the strongest and most reliable product available.

Plasma® 12-Strand

Plasma® 12-Strand is made up of 12 twisted strands, 6 right-handed and 6 left-handed, which when braided together, create a torque neutral construction. During processing, a polyurethane coating is added to provide protection against application hazards such as abrasion. The finished Plasma is very durable, more cut resistant than other synthetic ropes, and has a very soft hand. It also has excellent bending flex fatigue—far superior to wire rope. It is extremely flexible and conforms easily to surfaces when under load.

Plasma® 12x12

Plasma® 12x12 is a 12-strand braided rope in which each of the twelve strands is, in turn, a 12-strand rope, or braided primary strand. This construction addresses the most critical properties of the fibers to provide very high strength translation efficiency for larger ropes. This design allows for long lay lengths, making rope that is more flexible for bending applications, easy to inspect, and can be quickly spliced using standard 12-strand splicing techniques. Plasma 12x12 is supplied with a standard polyurethane finish, although other coatings can be applied to suit specific applications.



The 12x12 is made up of primary 12-strand ropes, which are in turn braided into a secondary 12-strand rope. The final form of a 12x12 is in essence a total of 144 individual strands.

3d. Rope Slings Configuration

Just as important as selecting the right fiber and construction, selecting the correct configuration will further enhance the performance of any sling. There are two primary configurations for fiber rope slings:

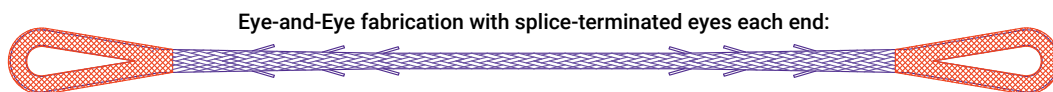
- Eye and Eye
- Endless Grommet

Each configuration has its own features and benefits.

Eye and Eye Slings

When spliced into an eye and eye sling, UHMWPE will essentially act as a size-for-size replacement for a traditional steel wire rope sling in terms of strength. Each end is terminated using a Cortland International-approved splice which becomes locked in place after proof load testing.

Due to the splice length and free span requirements as shown in the drawing below, eye and eye slings have minimum length that must be considered. The sling can be made only so short due to the splices. Refer to minimum sling length column in the Sling Rating charts beginning on page 40.

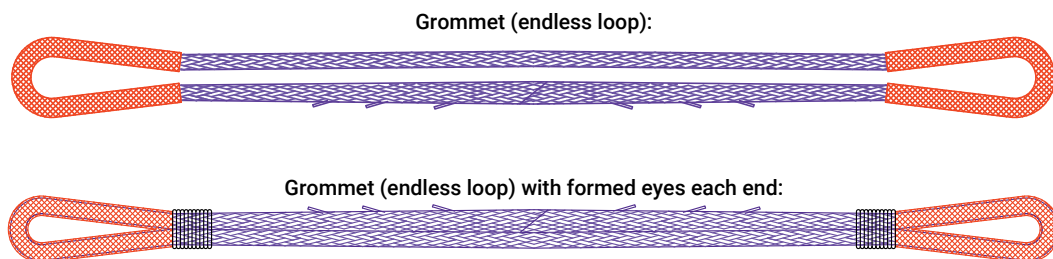


- Minimum D:d ratio in the eyes is 1:1
- Minimum eye length must be 3x the bearing surface diameter or pin diameter, to maintain the vertex angle below 30° (see vertex illustration on page 26)
- Rated capacity of eye-and-eye sling in a vertical pull includes splice efficiencies
- When basketing eye and eye slings the rated capacity will be affected when the basket point D:d ratio is less than 25:1 (see Bending Reductions section on pages 25–26)

Endless Grommet Slings

Grommets are manufactured by splicing the ends of a rope together to form a continuous loop. Compared to eye-and-eye slings, they have increased strength with little to no increase in the chosen rope diameter due to two (2) legs holding the load. Alternatively, the same load can be held with a smaller rope diameter due to the two (2) legs holding the load.

The breaking strength of endless grommet slings is directly affected by the pin diameter on which they are mounted.



- Grommet sling rated capacity is directly related to the contact curvature on which it will be used
- Grommet sling ultimate strength is based on applying a configuration factor (CF) to the single leg strength to which the rope is made
- For more information on D:d and configuration factor see pages 25–26.

3d. Rope Sling Configuration *Cont.*

Adjustable Length Slings

Cortland International offers Plasma® rope slings in an adjustable design: Extender™ slings. Extender slings have one permanent eye, and one eye that is adjustable, which means it can be sized to fit an application, then lengthened or shortened to fit a different application. A single Extender sling can solve lifting requirements in a wide variety of situations. Adjustable length lifting slings minimize the number of slings needed in stock.

Extender slings are currently available with vertical lifting capacities from 10 to 250 tons. All single leg or multi-leg Extender slings are proof-loaded to 2x WLL (5:1), and have less than 1% elongation at WLL.



Extender™ slings are adjustable to allow use in a variety of applications; they feature one permanent eye and one adjustable eye. The photos above show an example of an Extender sling in its minimum length configuration, and a second in its extended maximum length.



Jacket options are available, offering increased protection yet allowing for inspection of interior sling.

3d. Splicing & Terminations

All splice terminations must be made in accordance with splicing instructions provided by Cortland International and must be performed by a qualified person trained to fabricate these splices.

New Cortland fiber rope slings are rated using the splice type with which they are fabricated and delivered. The published MBL and rated capacity of a new Cortland International fiber rope sling take into consideration the splice; no further reduction for splicing needs to be calculated by the end-user.

Common Cortland-approved splice types for 12-strand and 12x12 are:

- Buried Lockstitch Splice
- Moran 5-4-3 Tuck Splice
- Modified Tuck Splice
- Locking Brummel

Refer to these relevant splicing instruction procedures on cortlandcompany.com or contact Cortland International contact@cortlandinternational.com for more information.

Effective rope termination splices produce the maximum strength possible throughout the entire fabricated assembly and are far more strength efficient than knots.

⚠ DANGER

- To achieve maximum strength, rope slings must never be used with a knot termination, which significantly reduces overall rope strength; by as much as 70%
- Mechanical end terminations such as clips, clamps or wedge sockets must not be used to fabricate fiber rope slings
- If thimbles do not have ears to prevent rotation of the thimble in the eye, they should be lashed to the rope
- All splices have tails; splice tails can either be taped and cut or buried depending on the application

When the application demands restrictive length tolerances or no change in diameter, alternative termination methods—such as potted terminations—can be used.



Splice termination with tails exposed

3d. Proof Loading

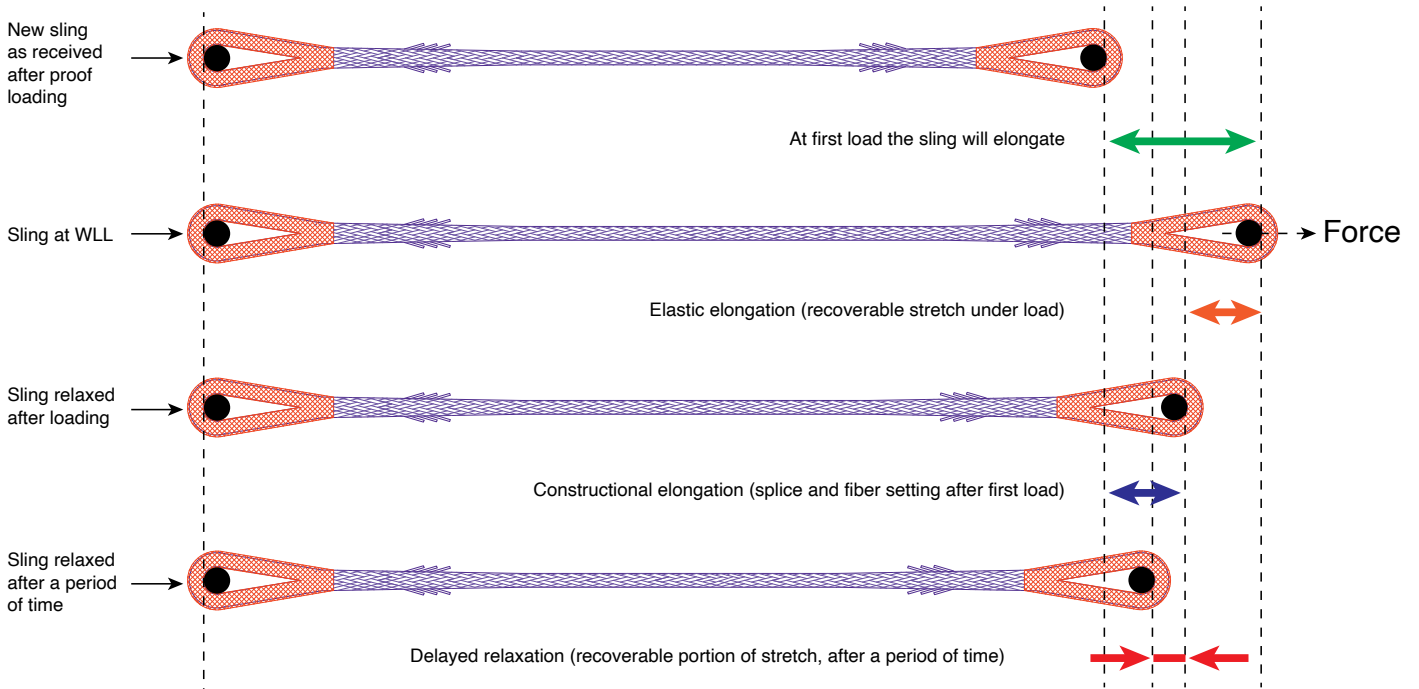
Proof-loading is a non-destructive process which subjects the completed sling assembly, to a predetermined load, typically 40% of the MBL of the rope.

After fabrication, Cortland International fiber rope slings will be subjected to preload or proof-load testing. Physical properties that change while load testing are:

- Diameter will decrease
- Length will increase

During the initial proof load testing, the rope will experience constructional elongation. The purpose of preloading is to remove constructional stretch and stabilize the elongation properties of the sling. During this process the rope will elongate approximately 5–6% and reduce in diameter.

It is at this time that the as-built fabricated length of the sling is taken (i.e., after proof load testing).



3d. Tagging

⚠ WARNING A fiber rope sling must not be used if the original rated capacity tag is missing or illegible. Initial sling identification and tagging shall be done by the fiber rope sling manufacturer/fabricator.

Cortland International fiber rope slings are equipped with tags which provide information detailing product information, serial number for material traceability and warnings for proper use.

Key components of a tag include:

- Name or trademark of manufacturer
- Serial number
- Date of manufacture
- Nominal diameter
- Nominal length
- Sling rated capacity
- Type of fiber material
- Number of legs, if more than one

etiflex.com	
MANUFACTURED IN ANACORTES, WA USA BY	
CORTLAND cortlandcompany.com	
DESCRIPTION:	
SLING TYPE:	RATED CAPACITY
IDENTIFICATION NUMBER:	VERTICAL:
MINIMUM TENSILE STRENGTH:	CHOKER:
FABRICATION DATE:	BASKET:



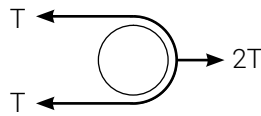
4a. Effect of Bending

When a sling is bent around a bearing contact surface such as a pin or sheave, the sling will experience a loss in overall strength. Care must be taken before every lift to ensure that the effect of bending has been considered.

Stress and Minimum Breaking Load

A sling will be overloaded when the stress inside the rope becomes too high. Stress is caused by both tension (*tensile stress*) and bending (*bending stress*).

When two legs of a sling are used to hold a load instead of one, both legs share the load. The tensile stress ($2T$) is cut in half.



However, this does not necessarily mean that the capacity of the sling is doubled. The decrease in tensile stress is partially offset by an increase in bending stress. The magnitude of this bending stress is dependent on the size and shape of the contact surface.

When determining the strength of a sling in bending, there are three subjects to consider: sling configuration (how the sling is made), hitch configuration (how the sling is used), and the D:d ratio of the sling (what the sling is bent around).

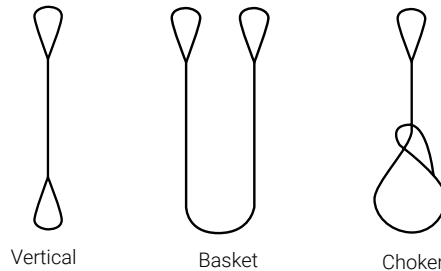
All sling bearing contact surfaces must be smooth, free from any burrs or surface irregularities, with a radius that is continuous throughout the bearing contact area. Special attention must be given to any contact surface with damaging edges, small radii, or abruptly changing radii (example: DIN hooks; refer to illustrations at the bottom of page 27).

Sling Configuration:

There are two main configurations into which a sling can be spliced, either an eye-and-eye sling (one tension leg) or a grommet sling (two tension legs) as shown on page 20. A grommet can generally achieve higher breaking loads than an eye-and-eye sling of the same rope size, because the load is shared between two legs.

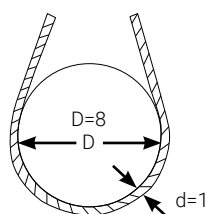
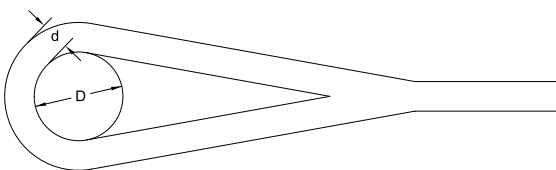
Hitch Configuration:

A sling can be used in multiple ways, such as a vertical, basket, or choker hitch as shown below. A basket hitch shares the load between two legs, achieving a higher breaking load than a vertical hitch. A choker hitch adds extra stress to the rope, and therefore has a lower breaking load than a vertical hitch. Rated loads for these hitch configurations can be found on pages 40–48.



D:d Ratio:

The bend severity from a bearing contact area on a sling can be expressed in terms of the D:d ratio. The D:d ratio is the ratio between the interfacing hardware curvature, or bend diameter (D), and the nominal sling diameter (d). The bending stress imposed by the interfacing hardware diameter onto the sling varies inversely with this ratio; i.e. the stress will increase as the bearing contact diameter decreases.

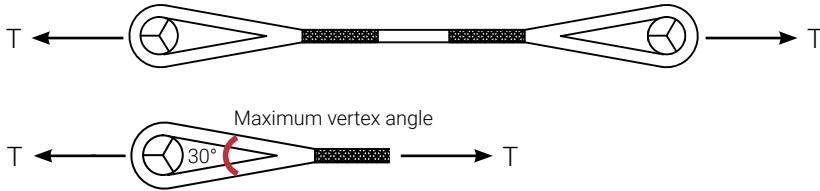


Note: When the interfacing hardware curvature (D) is eight times the fiber rope sling diameter (d), the D:d is expressed as 8:1

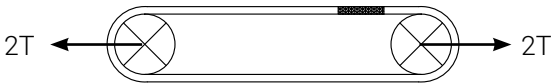
4a. Effect of Bending *Cont.*

General Minimum Breaking Load Considerations:

For an eye-and-eye sling in a vertical configuration, the highest stress occurs in the body of the sling, not the eyes. Therefore, bending stress is generally not a concern. The full rated capacity of the sling can be utilized as long as the D:d ratio between the sling eye and the contact point is greater than or equal to 1, and as long as the total vertex angle (α) of the eye is below 30° .

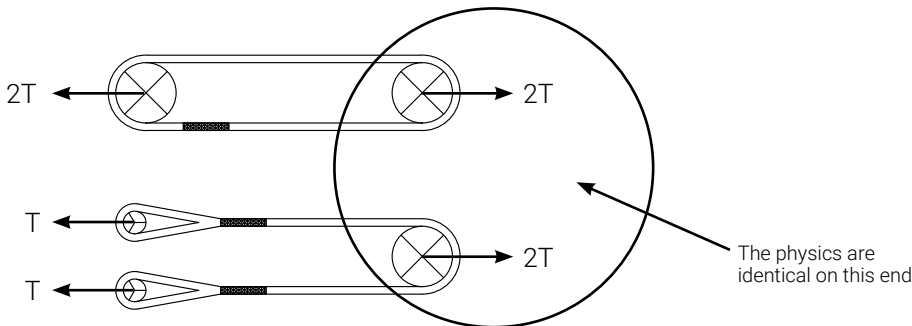


For a grommet sling, the rated capacity depends on the D:d ratio. Cortland International grommet slings vertical work load limits are based on an 8:1 ratio; they can therefore be used at full rated capacity at any ratio 8:1 or higher. For any diameter smaller than this, the load handling capacity of the fiber rope sling must be reduced. The lower the D:d ratio, the more the rope sling capacity must be reduced.



Because of these considerations, eye-and-eye slings in a vertical configuration have the advantage of tolerating lower D:d ratios compared to grommets. Grommets can achieve higher strengths and shorter working lengths than eye-and-eye slings, as long as a large enough D:d ratio is maintained. Tables of grommet strengths and their corresponding D:d ratios are shown on pages 40–48.

An eye-and-eye sling in a basket will have similar bending reductions as a grommet sling.



Due to frictional losses when basketing or doubling a sling over a bend, the MBL of the sling is reduced by 10% in accordance with the 55:45% guidance given in DNVGL-ST-N001. Cortland has performed extensive testing to understand the effect of bending on strength for our fiber rope slings. For further details and information relating to bending, please reference Cortland document ETN-002, available upon request.

4b. Contact Surfaces and Hardware

Compared to wire rope slings, fiber rope slings are significantly more flexible. They are pliable, grip loads well, and do not damage load surfaces. Unlike wire rope slings which can permanently deform when bent around a surface under load, the deformation of fiber rope slings is reversible.



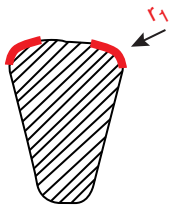
While this compression of a fiber rope sling itself does not reduce strength, if the surface it comes into contact with is not smooth, the fiber can abrade. Load handling hardware and attachment points must be maintained in good condition and kept free of burrs and rust. Abrasion can be diminished on fiber rope slings with appropriate wear protection (see following page).

When using a fiber rope sling in an application that previously used wire rope slings, it is important to ensure connection points and contact surfaces minimize abrasion and stress on fiber rope slings.

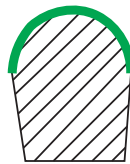
Any additional mechanical components such as end termination hardware, fittings,

and sling protection used as part of a fiber rope sling must be selected to meet the following requirements:

1. Suitability of components shall be verified by a qualified person.
2. The material shall be compatible with the mechanical and environmental requirements imposed on the sling.
3. Following ASME B30.9 guidelines, Cortland International recommends that thimbles have a minimum diameter at the bearing surface of at least 2 times the rope diameter.
4. All surfaces shall be cleanly finished and damaging edges removed so as not to cause damage to the rope.
5. Rigging hardware, when employed, shall meet the requirements of ASME B30.26 or other standards used for lifting.
6. Sling protection must be compatible and non-damaging to the fiber rope material. It must also be installed with proper manufacturer guidance.
7. Slings incorporating reused, repaired, or welded fittings shall undergo proof load in accordance with ASME B30.9 Section 4.6, and/or other applicable standards.
8. Hooks, when employed, shall meet the requirements of ASME B30.10 or other applicable standards.



A DIN hook has an inconstant (not smooth) bearing profile in which the smallest radii in the profile must be taken into consideration when calculating the MBL or bending loss in a sling.



Cortland International offers custom synthetic-friendly hardware solutions, with smooth and constant bearing profiles in sling contact areas, for load handling challenges.

4c. Sling Protection

If additional protection from the elements, cutting, abrasion, or mud ingress is needed, Cortland International offers several wear protection options. Fiber rope slings can be completely covered in protection, or simply protected in critical contact areas; e.g. the basket lifting point, or the eyes. Options include:

SX™

Combining the lightweight, abrasion resistant and non-water absorbing properties of UHMWPE fiber, SX protection is a tightly braided tubular structure which can be freefloating or fitted onto the sling to offer the highest protection from cuts and abrasion that Cortland offers.



SX wear protection

Cortland Cage™

Combining the lightweight, abrasion resistant and non-water absorbing properties of UHMWPE fiber, Cortland Cage protection is a loosely braided cover sleeve offering high protection from cuts and abrasion, yet allowing inspection of the sling interior.



Cortland Cage wear protection

Asgard™

Combining the lightweight, abrasion resistant and non-water absorbing properties of UHMWPE fiber, Asgard protection is a lightweight woven fabric structure which is easy to install and retrofit on existing slings, providing protection from cuts and abrasion.



Asgard wear protection

DXC™

Combining the lightweight, cost-effective properties of polyester fiber, DXC protection is a tightly braided tubular structure which can be freefloating or fitted onto the sling.



DXC wear protection

XT™

Combining the lightweight, cost-effective properties of polyester fiber, XT protection is a tightly braided tubular protection sleeve with proprietary heavy-duty, rigid polyurethane coating for use in harsh applications. XT sleeves can be fabricated to be free-floating, or fixed in place.



XT wear protection

PNW™

A cost-effective woven fabric material, PNW is the most commonly used protection for abrasion. This protection is available as a permanent installation, or in a removable / replaceable form with a hook-and-loop closure.



PNW (permanent)

For more information refer to our FL_036 Wear Protection brochure.



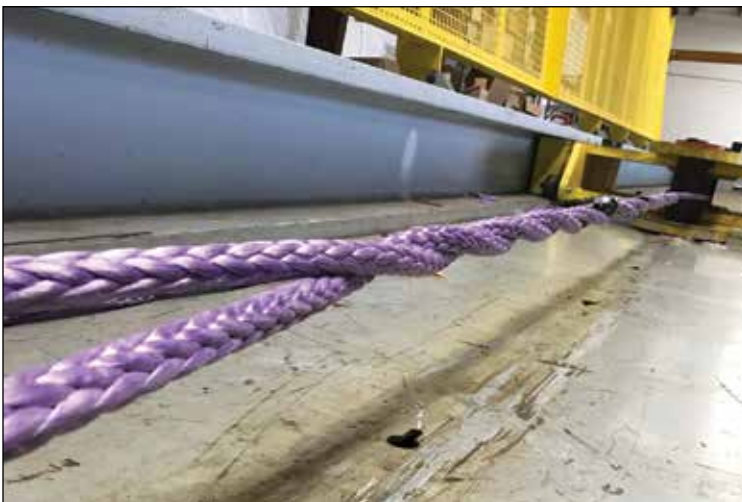
PNW (replaceable)

4d. Rope Twist

The 12-Strand and 12x12 constructions from Cortland International are torque neutral and designed to be used with no twist to properly share the load between the strands. Torque balanced fiber rope slings like our 12-strand and 12x12 designs do not tend to twist under load, therefore any twist must be externally induced. This could arise due to asymmetrical loading, off-axis loading, or because of accidental rotation during reeling.

If signs of twist are detected in a fiber rope sling, the twist should be removed or worked out. Continued loading of a rope sling while twisted can result in permanent deformation of the rope construction which can contribute to strength loss, and may cause hazardous operational issues, e.g., load spinning.

If torque or twist is expected in the application, contact Cortland International for a strength rating.



Cortland International has tested the effect of twist on fiber rope sling break strengths, both in eye and eye, and grommet configurations. For further information on twist and the effect on fiber rope slings, refer to our ETN_004 document for Plasma® rope slings, and ETN_020 document for Plasma grommets.

4e. Rope Operating Temperature

Users of fiber rope slings need to be aware of ambient, reflected, or frictional heating in applications, as well as proximity to localized heat sources such as open flames or welding torches. If it is anticipated that heat will be an issue, care must be taken to protect the fiber rope sling.

Signs of temperature damage include melting, fused or brittle strands and significantly reduced diameter. Note—fused strands must not be confused with strands that have been tightly compacted and stiffened due to high loads. Compressed strands can be separated, while fused strands cannot.

UHMWPE fiber rope slings must not be used in loading conditions with temperatures greater than 150°F (65°C). If high temperatures are unavoidable, an alternative high modulus synthetic fiber may be desirable that has a significantly higher critical temperature rating must be used. Cortland International manufactures fiber rope slings from heat resistant fibers such as Vectran® (LCP) and Technora® (Aramid).

Due to the critical nature of load handling operations, any sign of heat damage on a fiber rope sling is cause for immediate removal from service.



This is fiber compression. If the strands can be separated by flexing the rope, it is not heat damage.



Glossy or glazed areas, fused or melted strands are signs of heat damage.

4f. Handling & Storage Procedures

The service life of fiber rope slings can be prolonged with proper storage and care.

⚠ WARNING

Handling:

- Avoid dragging slings on the ground
- Avoid pulling on slings from single strands. Always handle the rope sling as a unit, not individual strands.
- Avoid pulling on slings by the tails of the splice if the tails are exposed
- Avoid exposing slings to contact with abrasive surfaces
- Do not weld, grind or cut metal in areas where slings are stored. Welding slag or sparks may damage the sling.
- Do not use or store near damaging chemicals.

Cleaning:

- Cortland International rope slings can be washed in hot or cold water to remove particulate matter without damage or loss of strength. It is recommended that only fresh water be used.
- Use of harsh or damaging cleansers must be avoided.
- Washed slings must be air-dried before storage or used immediately.
- Slings must NOT be pressure-washed.

Storage:

- Slings, rigging hardware and sling protection should be stored in a clean, dry area, out of direct sunlight and/or any source of ultraviolet light and away from sources of extreme temperatures.
- The storage location should also be free of environmental and mechanical damage, corrosion, dirt and grit.
- If stored on a pallet, make sure other items which may damage or cut the sling are not stacked on top of them.



Cortland International offers optional weather-proof storage totes to protect and store slings

5a. Inspection Points

All new, altered, or repaired slings must be inspected to ensure compliance with relevant application, regulatory, and statutory requirements. Additionally, slings must be inspected for damage before and after every use. Areas of concern must be reviewed by a qualified person to determine if the fiber rope sling should be removed from service.

Within a calendar year after the first time the sling is put into service, a thorough inspection must be conducted by a Cortland International, or Cortland-approved, representative. Following this, an annual logbook review and sling inspection must also be conducted by a Cortland, or Cortland-approved representative.

1 – Inspect the tag

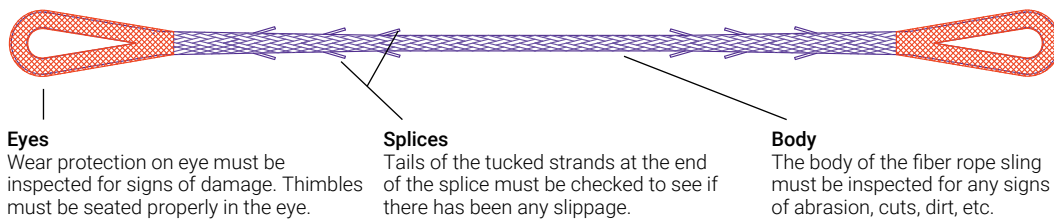
- Make sure the tag is in place and the mandatory information on the tag is legible.

2 – Inspect the wear protection

- Begin at the bearing surface of the eye, and work your way down the fiber rope sling
- Inspect the sling protection for cuts, snags, compression, abrasion and/or other damage.
 - If damage is detected on the protection, further inspection of the fiber rope strength member is required

3 – Inspect the fiber rope strength member

- Splice termination—refer to Cortland Moran 5-4-3 or Modified Tuck splice procedure to verify compliance
- Inspect the rope for abrasion, visible cuts or pulls in strands, inconsistencies in rope diameter, and glazed or heat-damaged (melted) fiber.
- “Hand-compress” the braid to open up the construction. By compressing the braided rope, both strand and internal wear/damage can be assessed (e.g. mass volume loss to abrasion, cutting or heat damage).



If a sling has several different modes of damage, their effects could be cumulative. Even if they do not individually meet the removal from service criteria, the combined effect must be considered.



Synthetic fiber rope sling being hand-compressed.



The rope sling can be inspected for internal wear / damage with the construction opened.

Recertification and Use of Modified or Repaired Plasma® Rope Slings

Cortland synthetic fiber rope slings can be re-spliced to a different length if required for use in another application. But the decision to re-purpose a Cortland rope sling must be made after careful inspection of the sling and a determination by a qualified person as to the suitability of the sling for further use.

5a. Abrasion

Abrasion is the wearing of fiber from frictional contact, resulting in a loss of load-bearing material. Abrasion is readily identified by the fuzzy appearance of the damaged fiber (i.e., broken filaments).











There are two primary types of abrasion which happen to a fiber rope sling when used:

1. External abrasion
2. Internal abrasion

External abrasion is the most common type of damage. External abrasion is caused by movement of the sling against another object. This type of abrasion is typically localized and not consistent through the entire length of the sling.

Internal abrasion is caused from movement between rope strands—also referred to as strand-on-strand abrasion. This type of abrasion is typically more indicative of a fiber rope sling which has been heavily used and is normally consistent throughout the length of the sling.

Visual inspection chart on Cortland International UHMWPE rope slings

Rating	External Abrasion	Internal Abrasion
<p>1 Like new (good to use)</p>		
<p>2 Light to moderate abrasion (good to use)</p>		
<p>3 Moderate abrasion (remove sling from service)</p>		
<p>4 Moderate to severe abrasion (remove sling from service)</p>		
<p>5 Severe abrasion (remove sling from service)</p>		

5a. Cuts

Cuts represent a significant potential hazard to user safety and overall fiber rope sling performance. Cuts may be identified by the even, squared-off ends at the point of damage.

While broken filaments have very little effect, partial cutting of strands and/or primary braids can create an imbalance in load-sharing, leading to significantly lower strength.

As a general rule of thumb during inspection:

1. For a 12x12 rope sling, cut primary braid strands do not have as much impact on strength as cut primary braids. However, all cuts should be thoroughly inspected to determine the severity of the cut.
2. One cut of 50% or more of a 12x1 strand, or a 12x12 primary braid, is cause for immediate removal from service.

For more information, see removal from service criteria on page 39.



The image above shows a cut primary braid. The cut can be readily identified by the squared off ends of the cut material. In this example 12 primary braid strands were severed.

5a. Pulled Primary Braids or Primary Strands

A pulled primary braid or primary braid strand occurs when one of the rope components is snagged by, or becomes caught on, some external projection and is partially pulled out of the rope structure, forming a loop.

Generally, when the rope is under tension it is very difficult to pull a loop of material. Most pulled braids or strands occur when the rope is relaxed. **▲ WARNING** In addition to unbalancing the rope structure, pulled braids or strands can create a dangerous situation if the loop becomes entangled on an object while the rope is being handled.

A pulled primary braid strand or primary braid is not cause to remove the sling from service unless the affected strand cannot be “worked” back into the rope construction by hand flexing and compressing the rope. If it cannot be worked back into the rope structure, the damaged section should be removed and the rope re-spliced or removed from service. **▲ WARNING** A pulled primary braid should never be cut.



Pulled primary braid



Pulled primary braid strand

5a. Burns

Virtually all synthetic fibers can be melted or charred due to exposure to elevated temperatures. This can be caused by excessive heat due to high frictional contact between the rope and a fixed surface or through exposure to some heat source such as a welding, open flame, etc.

Burns can be identified by a glassy fused area on the surface of the rope and a black color.



Example of burned and excessively melted fiber



Example of burned and partially melted fiber

5a. Structural Deformation

The surface of the rope must be checked for any change in the shape of the rope or variations in the cycle length or diameter.

Change in shape

Although very rare, it is possible for one or more of the primary strands to partially or totally fail inside the rope, with the broken ends remaining trapped inside the structure of the final braid. When this happens, the diameter of the rope at the point of failure will reduce, producing an hourglass shape along the surface of the rope. If this happens the rope sling must be removed from service.

Cycle length and diameter

Cycle length and diameter of the final braid must be measured at periodic intervals along the length of the rope to make sure that there are no irregularities in the construction. The cycle length is determined by measuring the length of six consecutive picks along the longitudinal axis of the rope. Pronounced differences in either measurement (cycle length or diameter) at some location indicate a structural abnormality. The fiber rope sling must be inspected thoroughly, including inside the final braid structure, if any variations in these measurements are found.

The diameter (or circumference) can be measured with a diameter tape, standard tape measure or by wrapping a piece of twine around the rope and then measuring the length of twine. It must be noted that as the rope is used, the diameter will decrease slightly, and the cycle length will increase uniformly. But if an isolated location of the fiber rope sling is drastically different, it must be investigated further.

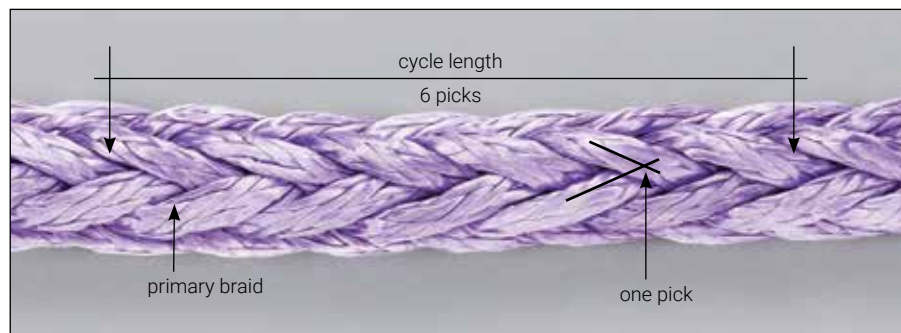
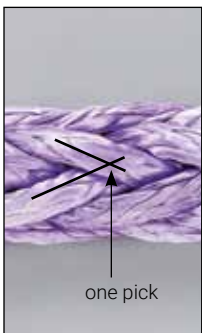


Example of structural deformation

Picks and cycle lengths:

Picks refers to the point at which one strand running in one direction, crosses over or under a strand running in the opposite direction. Pick density is expressed as picks per unit length.

The cycle length is the distance along the axis of the rope in which one strand makes one complete revolution around the circumference of the rope. A length of six consecutive picks running along the longitudinal axis of the final braid is the cycle length for a 12-strand rope.



5b. Removal from Service

The following is an inspection guideline for fiber rope slings, and conditions that dictate that the sling be removed from service.

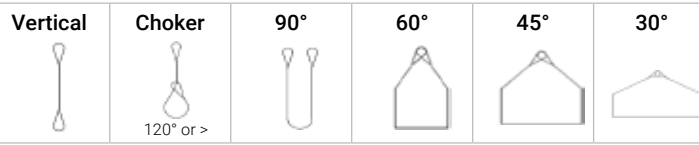
	Type	Condition	Action
1	Tagging	Tag is illegible or missing	Remove from service
2	External abrasion	Moderate and above (see page 34)	Remove from service
3	Internal abrasion	Melted or fused braids and strands; powdery or brittle fibers; moderate abrasion and above (see page 34)	Remove from service
4	Cuts	12x12 construction: three (3) or more cut primary braid strands within a primary strand cycle length, OR six (6) or more cut primary braid strands within a secondary braid cycle length, OR two (2) or more adjacent primary braid strands in a primary braid, OR 1/2-cut primary braid	Remove from service
		12x1 construction: 1/2-cut strand or more	Remove from service
5	Pulls	Primary braid strand (see page 36):	
		3 or less strands per primary braid per 3 cycle lengths	Work back into rope if possible. If not, then remove from service.
		More than 3 strands per primary braid per 3 cycle lengths	Remove from service
		Primary braid (see page 36):	
		1 primary braid per 3 cycle lengths	Work back into rope if possible. If not then remove from service.
		More than 1 primary braid	Remove from service
6	Burns or heat damage	Localized areas of fused and melted fibers	Remove from service
7	Structural deformation and/or distortion	Temporary compression	Work out compression
		Localized diameter area reduction, stiff and flat areas on rope unable to be flexed back into shape; any other permanent deformation	Remove from service
8	Splices	Exposed tucking tails	Re-tuck tails in body of rope
		Loose tucks	Repair splice if possible. If not, re-splice immediately or remove from service.
9	Contamination	Dirt or grit	If moderately or heavily contaminated externally, wash material off of rope. If moderately or heavily contaminated internally, repair or remove from service.
		Chemicals	If any suspicion of chemical contamination then consult Cortland International.
		Oil or grease	If moderate to heavy then wash rope surface with mild detergent or liquid soap. If it cannot be washed then remove from service.
10	Discoloration	Discoloration caused by unknown source	Remove from service
11	Wear Protection	Damaged/cut wear protection	Replace protection and inspect sling for associated damage

Plasma® Rope Sling Rating Charts

Eye & Eye Sling Ratings—LBS

Vertical, choker and basket hitches
Basket hitch at varying angles

Ratings based on Design Factor of 5:1



Sling Capacity Ratings at Work Load Limits (WLL) in Pounds Do Not Exceed WLL

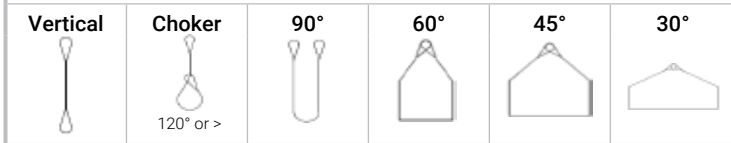
Nominal Size				Minimum Sling Length Ft/Inch	Plasma® 12-Strand					
Dia. inch	Dia. mm	Circ. inch	MBL-pounds		Vertical	Choker	90°	60°	45°	30°
1/4	6	3/4	8,000	2' 1"	1,600	1,120	3,200	2,770	2,260	1,600
5/16	8	15/16	11,700	2' 5"	2,340	1,630	4,680	4,050	3,300	2,340
3/8	9	1-1/8	17,500	2' 8"	3,500	2,450	7,000	6,060	4,940	3,500
7/16	11	1-1/4	21,000	3' 0"	4,200	2,940	8,400	7,270	5,930	4,200
1/2	12	1-1/2	31,300	3' 2"	6,260	4,380	12,500	10,800	8,850	6,260
9/16	14	1-3/4	37,900	3' 6"	7,580	5,300	15,100	13,100	10,700	7,580
5/8	16	2	51,400	3' 10"	10,200	7,190	20,500	17,800	14,500	10,200
3/4	18	2-1/4	68,500	4' 4"	13,700	9,590	27,400	23,700	19,300	13,700
13/16	20	2-1/2	74,000	4' 7"	14,800	10,300	29,600	25,600	20,900	14,800
7/8	22	2-3/4	92,600	4' 11"	18,500	12,900	37,000	32,000	26,100	18,500
1	24	3	110,000	5' 5"	22,000	15,400	44,000	38,100	31,100	22,000
1-1/16	26	3-1/4	129,200	5' 8"	25,800	18,000	51,600	44,700	36,500	25,800
1-1/8	28	3-1/2	147,000	5' 11"	29,400	20,500	58,800	50,900	41,500	29,400
1-1/4	30	3-3/4	165,000	6' 6"	33,000	23,100	66,000	57,100	46,600	33,000
1-5/16	32	4	196,000	6' 10"	39,200	27,400	78,400	67,800	55,400	39,200
1-1/2	36	4-1/2	221,000	7' 7"	44,200	30,900	88,400	76,500	62,500	44,200
					Plasma® 12x12					
1-5/8	40	5	291,000	9' 1"	58,200	40,700	116,400	100,800	82,300	58,200
1-3/4	44	5-1/2	314,000	9' 10"	62,800	43,900	125,600	108,700	88,800	62,800
2	48	6	355,000	11' 0"	71,000	49,700	142,000	122,900	100,400	71,000
2-1/8	52	6-1/2	428,000	11' 7"	85,600	59,900	171,200	148,200	121,000	85,600
2-1/4	56	7	481,000	12' 4"	96,200	67,300	192,400	166,600	136,000	96,200
2-1/2	60	7-1/2	530,000	13' 6"	106,000	74,200	212,000	183,500	149,900	106,000
2-5/8	64	8	596,000	14' 1"	119,200	83,400	238,400	206,400	168,500	119,200
2-3/4	68	8-1/2	660,000	14' 8"	132,000	92,400	264,000	228,600	186,600	132,000
3	72	9	780,000	16' 0"	156,000	109,200	312,000	270,100	220,600	156,000
3-1/8	76	9-1/2	850,000	16' 7"	170,000	119,000	340,000	294,400	240,400	170,000
3-1/4	80	10	940,000	17' 2"	188,000	131,600	376,000	325,600	265,800	188,000
3-1/2	84	10-1/2	1,108,000	18' 6"	221,600	155,100	443,200	383,800	313,300	221,600
3-5/8	88	11	1,250,000	19' 1"	250,000	175,000	500,000	433,000	353,500	250,000
3-3/4	92	11-1/2	1,317,000	19' 8"	263,400	184,300	526,000	456,200	372,500	263,400
4	96	12	1,520,000	21' 0"	304,000	212,800	608,000	526,000	429,900	304,000
4-1/8	100	12-1/2	1,622,000	21' 7"	324,400	227,000	648,000	561,000	458,700	324,400
4-1/4	104	13	1,697,000	22' 2"	339,400	237,500	678,000	587,000	479,900	339,400
4-1/2	108	13-1/2	1,827,000	23' 6"	365,400	255,700	730,000	632,000	516,000	365,400
4-5/8	112	14	1,880,000	24' 1"	376,000	263,200	752,000	651,000	531,000	376,000
4-3/4	116	14-1/2	1,927,000	24' 8"	385,400	269,700	770,000	667,000	545,000	385,400
5	120	15	2,069,500	25' 11"	413,900	289,700	827,000	716,000	585,000	413,900
5-1/8	124	15-1/2	2,212,000	26' 7"	442,400	309,600	884,000	766,000	625,000	442,400
5-1/4	128	16	2,355,000	27' 2"	471,000	329,700	942,000	815,000	666,000	471,000
5-1/2	132	16-1/2	2,497,500	28' 5"	499,500	349,600	999,000	865,000	706,000	499,500
5-5/8	136	17	2,640,000	29' 1"	528,000	369,600	1,056,000	914,000	746,000	528,000
5-3/4	140	17-1/2	2,782,500	29' 8"	556,000	389,500	1,113,000	963,000	787,000	556,000
6	144	18	2,925,000	30' 11"	585,000	409,000	1,170,000	1,013,000	827,000	585,000
6-1/8	148	18-1/2	3,068,000	31' 6"	613,000	429,000	1,227,000	1,062,000	867,000	613,000
6-1/4	152	19	3,210,500	32' 2"	642,000	449,000	1,284,000	1,112,000	908,000	642,000
6-1/2	156	19-1/2	3,353,000	33' 5"	670,000	469,000	1,341,000	1,161,000	948,000	670,000
6-5/8	160	20	3,496,000	34' 0"	699,000	489,000	1,398,000	1,211,000	988,000	699,000

Plasma® Rope Sling Rating Charts

Eye & Eye Sling Ratings—LBS

Vertical, choker and basket hitches
Basket hitch at varying angles

Ratings based on Design Factor of 5:1



Nominal Size				Minimum Sling Length Ft/Inch	Sling Capacity Ratings at Work Load Limits (WLL) in Pounds Do Not Exceed WLL					
Dia. inch	Dia. mm	Circ. inch	MBL-pounds		Plasma® 12-Strand					
6-3/4	164	20-1/2	3,638,500	34' 8"	727,000	509,000	1,455,000	1,260,000	1,029,000	727,000
7	168	21	3,781,000	35' 11"	756,000	529,000	1,512,000	1,309,000	1,069,000	756,000
7-1/8	172	21-1/2	3,963,500	36' 6"	792,000	554,000	1,585,000	1,372,000	1,121,000	792,000
7-1/4	176	22	4,066,000	37' 1"	813,000	569,000	1,626,000	1,408,000	1,150,000	813,000
7-1/2	180	22-1/2	4,209,000	38' 5"	841,000	589,000	1,683,000	1,458,000	1,190,000	841,000
7-5/8	184	23	4,351,500	39' 0"	870,000	609,000	1,740,000	1,507,000	1,230,000	870,000
7-3/4	188	23-1/2	4,494,000	39' 7"	898,000	629,000	1,797,000	1,556,000	1,271,000	898,000
8	192	24	4,637,000	40' 11"	927,000	649,000	1,854,000	1,606,000	1,311,000	927,000
8-1/8	196	24-1/2	4,779,000	41' 6"	955,000	669,000	1,911,000	1,655,000	1,351,000	955,000
8-1/4	200	25	4,922,000	42' 1"	984,000	689,000	1,968,000	1,705,000	1,392,000	984,000

Minimum Break Load (MBL) in pounds is determined using spliced test samples in accordance with Cordage Institute 1500-02 - Test Method for Fiber Ropes.

Minimum sling length on consult Cortland International fabricated Eye & Eye slings assumes 1) a compressed minimum eye length of 6.75 times the rope diameter in inches, and 2) a clear span area between splices of 10 times Cortland rope circumference in feet.

The recommended Design Factor (DF) of 5:1 on this chart is based on several existing sling standards including ASME B30.9. This design factor takes into account various factors including the use of Ultra High Molecular Weight Polyethylene (UHMWPE) fiber which is extremely durable and resistant to repeated high loads. Plasma® rope slings have and can be used with different DF ratios: however, this is a decision which must be made by a qualified person in conjunction with the rope manufacturer.

We recommend the use of wear protection around choking points. Please consult Cortland if you require the use of our fiber rope slings in a choker hitch at a lifting angle of less than 120°, following ASME B30.9 guidelines.

Bending Guidance

In theory, a sling used in a basket configuration could have twice the working load as a sling in a vertical configuration because two ropes are now holding the load instead of one. However, the decrease in tensile stress is partially offset by an increase in bending stress. The magnitude of this bending stress is dependent on the size and shape of the contact surface. Users must account for the bending strength loss with an efficiency factor as shown below in the Reduced Basket Capacity Calculation.

The bending efficiency reduces as the D:d ratio is reduced. Example: a 5:1 D:d ratio provides 80% efficiency.

Reduced Basket Capacity Calculation

$C = B \times e$

C = Reduced Basket Capacity due to bending efficiency reduction

B = Rated Basket Capacity with consideration of horizontal sling fleet angle

e = Bending efficiency percentage

Represents a contact surface that is equal to or greater than the rope diameter

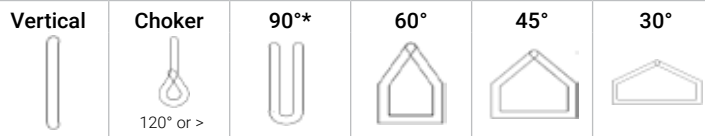
Represents a contact surface with a D:d ratio of one or greater. Refer to the Efficiency Table for deductions as needed.

Efficiency Table	
D:d Ratio	eff % (e)
25:1	100.0%
8:1	82.5%
5:1	80.0%
3:1	75.0%
2:1	72.5%
1:1	65.0%

Plasma® Rope Sling Rating Charts

Endless Grommet Sling Ratings—LBS

One splice in one leg
 Vertical, choker and basket hitches
 Basket hitch at varying angles
 Ratings based on Design Factor of 5:1
 and D:d of 8:1



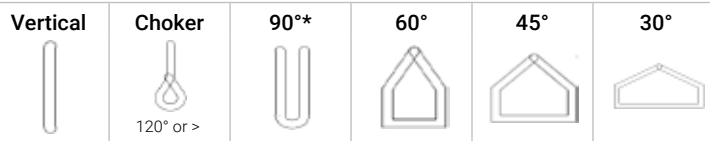
Nominal Size				Minimum Sling Length Ft/Inch	Sling Capacity Ratings at Work Load Limits (WLL) in Pounds Do Not Exceed WLL					
Dia. inch	Dia. mm	Circ. inch	MBL-pounds		Plasma® 12-Strand					
1/4	6	3/4	13,200	0' 6"	2,640	1,120	4,750	4,110	3,360	2,370
5/16	8	15/16	19,305	0' 8"	3,860	1,630	6,940	6,010	4,910	3,470
3/8	9	1-1/8	28,875	0' 10"	5,770	2,450	10,300	9,000	7,350	5,190
7/16	11	1-1/4	34,650	0' 11"	6,930	2,940	12,400	10,800	8,820	6,230
1/2	12	1-1/2	51,645	1' 0"	10,300	4,380	18,500	16,100	13,100	9,290
9/16	14	1-3/4	62,535	1' 2"	12,500	5,300	22,500	19,400	15,900	11,200
5/8	16	2	84,810	1' 4"	16,900	7,190	30,500	26,400	21,500	15,200
3/4	18	2-1/4	113,025	1' 6"	22,600	9,590	40,600	35,200	28,700	20,300
13/16	20	2-1/2	122,100	1' 8"	24,400	10,300	43,900	38,000	31,000	21,900
7/8	22	2-3/4	152,790	1' 10"	30,500	12,900	55,000	47,600	38,800	27,500
1	24	3	181,500	2' 0"	36,300	15,400	65,300	56,500	46,200	32,600
1-1/16	26	3-1/4	213,180	2' 2"	42,600	18,000	76,700	66,400	54,200	38,300
1-1/8	28	3-1/2	242,550	2' 4"	48,500	20,500	87,300	75,600	61,700	43,600
1-1/4	30	3-3/4	272,250	2' 6"	54,400	23,100	98,000	84,800	69,300	49,000
1-5/16	32	4	323,400	2' 8"	64,600	27,400	116,400	100,800	82,300	58,200
1-1/2	36	4-1/2	364,650	3' 0"	72,900	30,900	131,200	113,600	92,800	65,600
					Plasma® 12x12					
1-5/8	40	5	480,150	3' 4"	96,000	40,700	172,800	149,600	122,200	86,400
1-3/4	44	5-1/2	518,100	3' 6"	103,600	43,900	186,500	161,500	131,800	93,200
2	48	6	585,750	4' 0"	117,100	49,700	210,800	182,600	149,100	105,400
2-1/8	52	6-1/2	706,200	4' 4"	141,200	59,900	254,200	220,100	179,700	127,100
2-1/4	56	7	793,650	4' 6"	158,700	67,300	285,700	247,400	202,000	142,800
2-1/2	60	7-1/2	874,500	5' 0"	174,900	74,200	314,800	272,600	222,600	157,400
2-5/8	64	8	983,400	5' 4"	196,600	83,400	354,000	306,500	250,300	177,000
2-3/4	68	8-1/2	1,089,000	5' 6"	217,800	92,400	392,000	339,500	277,200	196,000
3	72	9	1,287,000	6' 0"	257,400	109,200	463,300	401,200	327,600	231,600
3-1/8	76	9-1/2	1,402,500	6' 4"	280,500	119,000	504,000	437,200	357,000	252,400
3-1/4	80	10	1,551,000	6' 6"	310,200	131,600	558,000	483,500	394,800	279,100
3-1/2	84	10-1/2	1,828,200	7' 0"	365,600	155,100	658,000	569,000	465,300	329,000
3-5/8	88	11	2,062,500	7' 4"	412,500	175,000	742,000	643,000	525,000	371,200
3-3/4	92	11-1/2	2,173,050	7' 6"	434,600	184,300	782,000	677,000	553,000	391,100
4	96	12	2,508,000	8' 0"	501,000	212,800	902,000	781,000	638,000	451,400
4-1/8	100	12-1/2	2,676,300	8' 4"	535,000	227,000	963,000	834,000	681,000	481,700
4-1/4	104	13	2,800,050	8' 6"	560,000	237,500	1,008,000	872,000	712,000	504,000
4-1/2	108	13-1/2	3,014,550	9' 0"	602,000	255,700	1,085,000	939,000	767,000	542,000
4-5/8	112	14	3,102,000	9' 4"	620,000	263,200	1,116,000	967,000	789,000	558,000
4-3/4	116	14-1/2	3,179,550	9' 6"	635,000	269,700	1,144,000	991,000	809,000	572,000
5	120	15	3,414,675	10' 0"	682,000	289,700	1,229,000	1,064,000	869,000	614,000
5-1/8	124	15-1/2	3,649,800	10' 4"	729,000	309,600	1,313,000	1,137,000	929,000	656,000
5-1/4	128	16	3,885,750	10' 6"	777,000	329,700	1,398,000	1,211,000	989,000	699,000
5-1/2	132	16-1/2	4,120,875	11' 0"	824,000	349,600	1,483,000	1,284,000	1,049,000	741,000
5-5/8	136	17	4,356,000	11' 4"	871,000	369,600	1,568,000	1,358,000	1,108,000	784,000
5-3/4	140	17-1/2	4,591,125	11' 6"	918,000	389,500	1,652,000	1,431,000	1,168,000	826,000
6	144	18	4,826,250	12' 0"	965,000	409,000	1,737,000	1,504,000	1,228,000	868,000
6-1/8	148	18-1/2	5,062,200	12' 4"	1,012,000	429,000	1,822,000	1,578,000	1,288,000	911,000

Chart continues on next page, along with caution statements and effect of bending considerations.

Plasma® Rope Sling Rating Charts

Endless Grommet Sling Ratings—LBS

One splice in one leg
 Vertical, choker and basket hitches
 Basket hitch at varying angles
 Ratings based on Design Factor of 5:1 and D:d of 8:1



Nominal Size				Minimum Sling Length Ft/Inch	Sling Capacity Ratings at Work Load Limits (WLL) in Pounds Do Not Exceed WLL					
Dia. inch	Dia. mm	Circ. inch	MBL-pounds		Plasma® 12-Strand					
6-1/4	152	19	5,297,325	12' 6"	1,059,000	449,000	1,907,000	1,651,000	1,348,000	953,000
6-1/2	156	19-1/2	5,532,450	13' 0"	1,106,000	469,000	1,991,000	1,724,000	1,408,000	995,000
6-5/8	160	20	5,768,400	13' 4"	1,153,000	489,000	2,076,000	1,798,000	1,468,000	1,038,000
6-3/4	164	20-1/2	6,003,525	13' 6"	1,200,000	509,000	2,161,000	1,871,000	1,528,000	1,080,000
7	168	21	6,238,650	14' 0"	1,247,000	529,000	2,245,000	1,945,000	1,588,000	1,122,000
7-1/8	172	21-1/2	6,539,775	14' 4"	1,307,000	554,000	2,354,000	2,038,000	1,664,000	1,177,000
7-1/4	176	22	6,708,900	14' 6"	1,341,000	569,000	2,415,000	2,091,000	1,707,000	1,207,000
7-1/2	180	22-1/2	6,944,850	15' 0"	1,388,000	589,000	2,500,000	2,165,000	1,767,000	1,250,000
7-5/8	184	23	7,179,975	15' 4"	1,435,000	609,000	2,584,000	2,238,000	1,827,000	1,292,000
7-3/4	188	23-1/2	7,415,100	15' 6"	1,483,000	629,000	2,669,000	2,311,000	1,887,000	1,334,000
8	192	24	7,651,050	16' 0"	1,530,000	649,000	2,754,000	2,385,000	1,947,000	1,377,000
8-1/8	196	24-1/2	7,885,350	16' 4"	1,577,000	669,000	2,838,000	2,458,000	2,007,000	1,419,000
8-1/4	200	25	8,121,300	16' 6"	1,624,000	689,000	2,923,000	2,531,000	2,067,000	1,461,000

* This MBL includes a 10% reduction due to 55:45% load sharing. For more information, see page 26. Minimum Break Load (MBL) in pounds is determined using spliced test samples in accordance with Cordage Institute 1500-02 - Test Method for Fiber Ropes. Specifications for endless loop (grommet) Plasma® rope slings assume one end-to-end splice. The length of splice determines the minimum length of a grommet sling.

The recommended Design Factor (DF) of 5:1 on this chart is based on several existing sling standards including ASME B30.9. This design factor takes into account various factors including the use of Ultra High Molecular Weight Polyethylene (UHMWPE) fiber which is extremely durable and resistant to repeated high loads. Plasma® rope slings have and can be used with different DF ratios: however, this is a decision which must be made by a qualified person in conjunction with the rope manufacturer.

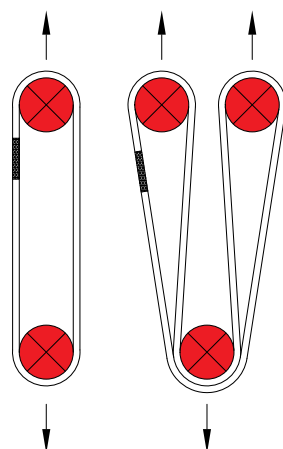
Please consult Cortland International if you require the use of our fiber rope slings in a choker hitch at a lifting angle of less than 120°, following ASME B30.9 guidelines.

Bending Guidance

In theory, a sling used in a basket configuration could have twice the working load as a sling in a vertical configuration because there are double the number of supporting strands. However, the decrease in tensile stress is partially offset by an increase in bending stress. The magnitude of this bending stress is dependent on the size and shape of the contact surface. Users must account for the bending strength loss with an efficiency factor as shown below in the Reduced Basket Capacity Calculation.

The bending efficiency reduces as the D:d ratio is reduced. Example: a 5:1 D:d ratio provides 97% efficiency.

Reduced Basket Capacity Calculation
$C = B \times e$
C = Reduced Basket Capacity due to bending efficiency reduction
B = Rated Basket Capacity with consideration of horizontal sling fleet angle
e = Bending efficiency percentage



⊗ Represents a contact surface with a D:d ratio of one or greater. Refer to the Efficiency Table for deductions as needed.

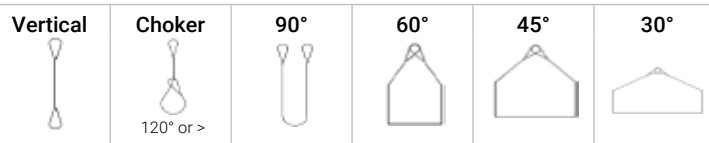
Efficiency Table	
D:d Ratio	eff % (e)
8:1	100.0%
5:1	97.0%
3:1	91.0%
2:1	88.0%
1:1	79.0%

Plasma® Rope Sling Rating Charts

Eye & Eye Sling Ratings—tonnes

Vertical, choker and basket hitches
Basket hitch at varying angles

Ratings based on Design Factor of 5:1



Sling Capacity Ratings at Work Load Limits (WLL) in tonnes
Do Not Exceed WLL

Nominal Size				Minimum Sling Length m	Plasma® 12-Strand					
Dia. inch	Dia. mm	Circ. inch	MBL tonnes		Vertical	Choker	90°	60°	45°	30°
1/4	6	3/4	3.6	0.7	0.7	0.5	1.4	1.2	1.0	0.7
5/16	8	15/16	5.3	0.8	1.0	0.7	2.1	1.8	1.5	1.0
3/8	9	1-1/8	7.9	0.9	1.5	1.1	3.1	2.7	2.2	1.5
7/16	11	1-1/4	9.5	0.9	1.9	1.3	3.8	3.2	2.6	1.9
1/2	12	1-1/2	14.2	1.0	2.8	1.9	5.6	4.9	4.0	2.8
9/16	14	1-3/4	17.2	1.1	3.4	2.4	6.8	5.9	4.8	3.4
5/8	16	2	23.3	1.2	4.6	3.2	9.3	8.0	6.5	4.6
3/4	18	2-1/4	31.1	1.3	6.2	4.3	12.4	10.7	8.7	6.2
13/16	20	2-1/2	33.6	1.4	6.7	4.6	13.4	11.6	9.4	6.7
7/8	22	2-3/4	42.0	1.5	8.4	5.8	16.8	14.5	11.8	8.4
1	24	3	49.9	1.7	9.9	6.9	19.9	17.2	14.1	9.9
1-1/16	26	3-1/4	58.6	1.8	11.7	8.2	23.4	20.3	16.5	11.7
1-1/8	28	3-1/2	66.7	1.8	13.3	9.3	26.6	23.0	18.8	13.3
1-1/4	30	3-3/4	74.8	2.0	14.9	10.4	29.9	25.9	21.1	14.9
1-5/16	32	4	88.9	2.1	17.7	12.4	35.5	30.7	25.1	17.7
1-1/2	36	4-1/2	100.2	2.3	20.0	14.0	40.0	34.7	28.3	20.0
					Plasma® 12x12					
1-5/8	40	5	131	2.8	26	18	52	45	37	26
1-3/4	44	5-1/2	142	3.0	28	19	56	49	40	28
2	48	6	161	3.4	32	22	64	55	45	32
2-1/8	52	6-1/2	194	3.6	38	27	77	67	54	38
2-1/4	56	7	218	3.8	43	30	87	75	61	43
2-1/2	60	7-1/2	240	4.1	48	33	96	83	67	48
2-5/8	64	8	270	4.3	54	37	108	93	76	54
2-3/4	68	8-1/2	299	4.5	59	41	119	103	84	59
3	72	9	353	4.9	70	49	141	122	99	70
3-1/8	76	9-1/2	385	5.1	77	53	154	133	108	77
3-1/4	80	10	426	5.3	85	59	170	147	120	85
3-1/2	84	10-1/2	502	5.7	100	70	200	173	141	100
3-5/8	88	11	566	5.9	113	79	226	196	160	113
3-3/4	92	11-1/2	597	6.0	119	83	238	206	168	119
4	96	12	689	6.4	137	96	275	238	194	137
4-1/8	100	12-1/2	735	6.6	147	102	294	254	207	147
4-1/4	104	13	769	6.8	153	107	307	266	217	153
4-1/2	108	13-1/2	828	7.2	165	115	331	286	234	165
4-5/8	112	14	852	7.4	170	119	340	295	240	170
4-3/4	116	14-1/2	874	7.6	174	122	349	302	247	174
5	120	15	938	7.9	187	131	375	324	265	187
5-1/8	124	15-1/2	1,003	8.1	200	140	401	347	283	200
5-1/4	128	16	1,068	8.3	213	149	427	369	302	213
5-1/2	132	16-1/2	1,132	8.7	226	158	452	392	320	226
5-5/8	136	17	1,197	8.9	239	167	478	414	338	239
5-3/4	140	17-1/2	1,262	9.1	252	176	504	437	356	252
6	144	18	1,326	9.5	265	185	530	459	375	265
6-1/8	148	18-1/2	1,391	9.6	278	194	556	481	393	278

Chart continues on next page, along with caution statements and effect of bending considerations.

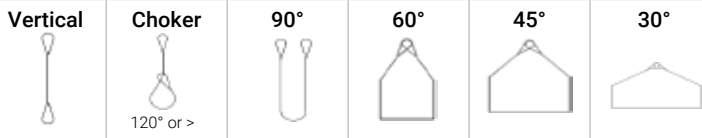
Plasma® Rope Sling Rating Charts

Eye & Eye Sling Ratings—tonnes

Vertical, choker and basket hitches
Basket hitch at varying angles

Ratings based on Design Factor of 5:1

Nominal Size				Minimum Sling Length m	Sling Capacity Ratings at Work Load Limits (WLL) in tonnes Do Not Exceed WLL					
Dia. inch	Dia. mm	Circ. inch	MBL tonnes		Plasma® 12-Strand					
6-1/4	152	19	1,456	9.8	291	203	582	504	411	291
6-1/2	156	19-1/2	1,520	10.2	304	212	608	526	429	304
6-5/8	160	20	1,585	10.4	317	221	634	549	448	317
6-3/4	164	20-1/2	1,650	10.6	330	231	660	571	466	330
7	168	21	1,715	11.0	343	240	686	594	485	343
7-1/8	172	21-1/2	1,797	11.2	359	251	718	622	508	359
7-1/4	176	22	1,844	11.4	368	258	737	638	521	368
7-1/2	180	22-1/2	1,909	11.7	381	267	763	661	539	381
7-5/8	184	23	1,973	11.9	394	276	789	683	558	394
7-3/4	188	23-1/2	2,038	12.1	407	285	815	705	576	407
8	192	24	2,103	12.5	420	294	841	728	594	420
8-1/8	196	24-1/2	2,167	12.7	433	303	866	750	612	433
8-1/4	200	25	2,232	12.9	446	312	892	773	631	446



Minimum Break Load (MBL) in tonnes is determined using spliced test samples in accordance with Cordage Institute 1500-02 - Test Method for Fiber Ropes.

Minimum sling length on consult Cortland International fabricated Eye & Eye slings assumes 1) a compressed minimum eye length of 6.75 times the rope diameter in millimeters, and 2) a clear span area between splices of 10 times Cortland rope circumference in feet.

The recommended Design Factor (DF) of 5:1 on this chart is based on several existing sling standards including ASME B30.9. This design factor takes into account various factors including the use of Ultra High Molecular Weight Polyethylene (UHMWPE) fiber which is extremely durable and resistant to repeated high loads. Plasma® rope slings have and can be used with different DF ratios: however, this is a decision which must be made by a qualified person in conjunction with the rope manufacturer.

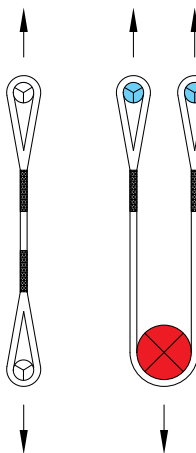
We recommend the use of wear protection around choking points. Please consult Cortland if you require the use of our fiber rope slings in a choker hitch at a lifting angle of less than 120°, following ASME B30.9 guidelines.

Bending Guidance

In theory, a sling used in a basket configuration could have twice the working load as a sling in a vertical configuration because two ropes are now holding the load instead of one. However, the decrease in tensile stress is partially offset by an increase in bending stress. The magnitude of this bending stress is dependent on the size and shape of the contact surface. Users must account for the bending strength loss with an efficiency factor as shown below in the Reduced Basket Capacity Calculation.

The bending efficiency reduces as the D:d ratio is reduced. Example: a 5:1 D:d ratio provides 80% efficiency.

Reduced Basket Capacity Calculation
$C = B \times e$
C = Reduced Basket Capacity due to bending efficiency reduction
B = Rated Basket Capacity with consideration of horizontal sling fleet angle
e = Bending efficiency percentage



Represents a contact surface that is equal to or greater than the rope diameter

Represents a contact surface with a D:d ratio of one or greater. Refer to the Efficiency Table for deductions as needed.

Efficiency Table	
D:d Ratio	eff % (e)
25:1	100.0%
8:1	82.5%
5:1	80.0%
3:1	75.0%
2:1	72.5%
1:1	65.0%

Plasma® Rope Sling Rating Charts

Endless Grommet Sling

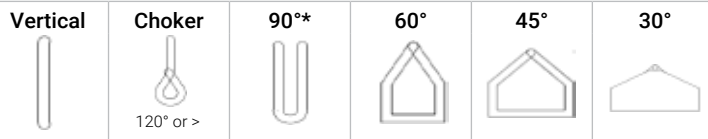
Ratings—tonnes

One splice in one leg

Vertical, choker and basket hitches

Basket hitch at varying angles

Ratings based on Design Factor of 5:1
and D:d of 8:1



Sling Capacity Ratings at Work Load Limits (WLL) in tonnes
Do Not Exceed WLL

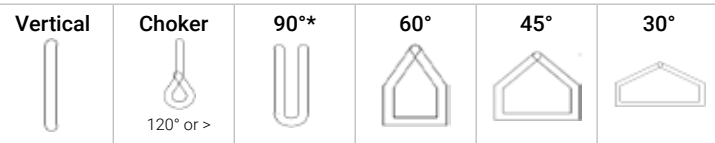
Nominal Size				Minimum Sling Length m	Plasma® 12-Strand					
Dia. inch	Dia. mm	Circ. inch	MBL tonnes		Vertical	Choker	90°*	60°	45°	30°
1/4	6	3/4	5.9	0.2	1.1	0.5	2.1	1.8	1.5	1.0
5/16	8	15/16	8.7	0.2	1.7	0.7	3.1	2.7	2.2	1.5
3/8	9	1-1/8	13.0	0.3	2.6	1.1	4.7	4.0	3.3	2.3
7/16	11	1-1/4	15.7	0.3	3.1	1.3	5.6	4.9	4.0	2.8
1/2	12	1-1/2	23.4	0.4	4.6	1.9	8.4	7.3	5.9	4.2
9/16	14	1-3/4	28.3	0.4	5.6	2.4	10.2	8.8	7.2	5.1
5/8	16	2	38.4	0.4	7.6	3.2	13.8	11.9	9.7	6.9
3/4	18	2-1/4	51.2	0.5	10.2	4.3	18.4	15.9	13.0	9.2
13/16	20	2-1/2	55.3	0.5	11.0	4.6	19.9	17.2	14.0	9.9
7/8	22	2-3/4	69.3	0.6	13.8	5.8	24.9	21.6	17.6	12.4
1	24	3	82.3	0.7	16.4	6.9	29.6	25.6	20.9	14.8
1-1/16	26	3-1/4	96.6	0.7	19.3	8.2	34.8	30.1	24.6	17.4
1-1/8	28	3-1/2	110.0	0.7	22.0	9.3	39.6	34.3	28.0	19.8
1-1/4	30	3-3/4	123.4	0.8	24.6	10.4	44.4	38.5	31.4	22.2
1-5/16	32	4	146.6	0.9	29.3	12.4	52.8	45.7	37.3	26.4
1-1/2	36	4-1/2	165.4	1.0	33.0	14.0	59.5	51.5	42.1	29.7
					Plasma® 12x12					
1-5/8	40	5	217	1.0	43	18	78	67	55	39
1-3/4	44	5-1/2	235	1.1	47	19	84	73	59	42
2	48	6	265	1.3	53	22	95	82	67	47
2-1/8	52	6-1/2	320	1.3	64	27	115	99	81	57
2-1/4	56	7	359	1.4	71	30	129	112	91	64
2-1/2	60	7-1/2	396	1.6	79	33	142	123	100	71
2-5/8	64	8	446	1.7	89	37	160	139	113	80
2-3/4	68	8-1/2	493	1.7	98	41	177	154	125	88
3	72	9	583	1.9	116	49	210	182	148	105
3-1/8	76	9-1/2	636	2.0	127	53	229	198	161	114
3-1/4	80	10	703	2.0	140	59	253	219	179	126
3-1/2	84	10-1/2	829	2.2	165	70	298	258	211	149
3-5/8	88	11	935	2.3	187	79	336	291	238	168
3-3/4	92	11-1/2	985	2.3	197	83	354	307	250	177
4	96	12	1,137	2.5	227	96	409	354	289	204
4-1/8	100	12-1/2	1,213	2.6	242	103	437	378	309	218
4-1/4	104	13	1,270	2.6	254	107	457	395	323	228
4-1/2	108	13-1/2	1,367	2.8	273	116	492	426	348	246
4-5/8	112	14	1,407	2.9	281	119	506	438	358	253
4-3/4	116	14-1/2	1,442	2.9	288	122	519	449	367	259
5	120	15	1,548	3.1	309	131	557	482	394	278
5-1/8	124	15-1/2	1,655	3.2	331	140	595	516	421	297
5-1/4	128	16	1,762	3.3	352	149	634	549	448	317
5-1/2	132	16-1/2	1,869	3.4	373	158	672	582	475	336
5-5/8	136	17	1,975	3.5	395	167	711	616	502	355
5-3/4	140	17-1/2	2,082	3.6	416	176	749	649	530	374
6	144	18	2,187	3.7	437	185	787	681	556	393
6-1/8	148	18-1/2	2,294	3.8	458	194	825	715	583	412

Chart continues on next page, along with caution statements and effect of bending considerations.

Plasma® Rope Sling Rating Charts

Endless Grommet Sling Ratings—tonnes

One splice in one leg
 Vertical, choker and basket hitches
 Basket hitch at varying angles
 Ratings based on Design Factor of 5:1
 and D:d of 8:1



Nominal Size				Minimum Sling Length m	Sling Capacity Ratings at Work Load Limits (WLL) in tonnes Do Not Exceed WLL					
Dia. inch	Dia. mm	Circ. inch	MBL tonnes		Plasma® 12-Strand					
6-1/4	152	19	2,400	3.9	480	203	864	748	611	432
6-1/2	156	19-1/2	2,507	4.0	501	212	902	781	638	451
6-5/8	160	20	2,614	4.1	522	221	941	815	665	470
6-3/4	164	20-1/2	2,720	4.2	544	230	979	848	692	489
7	168	21	2,827	4.3	565	239	1017	881	719	508
7-1/8	172	21-1/2	2,963	4.4	592	251	1066	923	754	533
7-1/4	176	22	3,040	4.5	608	257	1094	947	773	547
7-1/2	180	22-1/2	3,147	4.6	629	267	1133	981	801	566
7-5/8	184	23	3,253	4.7	650	276	1171	1014	828	585
7-3/4	188	23-1/2	3,360	4.8	672	285	1209	1047	855	604
8	192	24	3,467	4.9	693	294	1248	1081	882	624
8-1/8	196	24-1/2	3,573	5.0	714	303	1286	1114	909	643
8-1/4	200	25	3,680	5.1	736	312	1324	1147	936	662

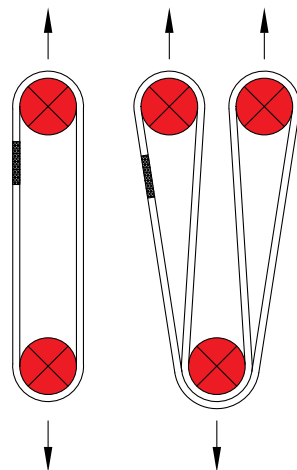
* This MBL includes a 10% reduction due to 55:45% load sharing. For more information, see page 26. Minimum Break Load (MBL) in tonnes is determined using spliced test samples in accordance with Cordage Institute 1500-02 - Test Method for Fiber Ropes. Specifications for endless loop (grommet) Plasma® rope slings assume one end-to-end splice. The length of splice determines the minimum length of a grommet sling. The recommended Design Factor (DF) of 5:1 on this chart is based on several existing sling standards including ASME B30.9. This design factor takes into account various factors including the use of Ultra High Molecular Weight Polyethylene (UHMWPE) fiber which is extremely durable and resistant to repeated high loads. Plasma rope slings have and can be used with different DF ratios: however, this is a decision which must be made by a qualified person in conjunction with the rope manufacturer. We recommend the use of wear protection around choking points. Please consult Cortland International if you require the use of our fiber rope slings in a choker hitch at a lifting angle of less than 120°, following ASME B30.9 guidelines.

Bending Guidance

In theory, a sling used in a basket configuration could have twice the working load as a sling in a vertical configuration because there are double the number of supporting strands. However, the decrease in tensile stress is partially offset by an increase in bending stress. The magnitude of this bending stress is dependent on the size and shape of the contact surface. Users must account for the bending strength loss with an efficiency factor as shown below in the Reduced Basket Capacity Calculation.

The bending efficiency reduces as the D:d ratio is reduced. Example: a 5:1 D:d ratio provides 97% efficiency.

Reduced Basket Capacity Calculation
$C = B \times e$
C = Reduced Basket Capacity due to bending efficiency reduction
B = Rated Basket Capacity with consideration of horizontal sling fleet angle
e = Bending efficiency percentage



⊗ Represents a contact surface with a D:d ratio of one or greater. Refer to the Efficiency Table for deductions as needed.

Efficiency Table	
D:d Ratio	eff % (e)
8:1	100.0%
5:1	97.0%
3:1	91.0%
2:1	88.0%
1:1	79.0%

Plasma® Rope Sling Rating Charts

Extender™ Slings Ratings – LBS

Vertical



Basket



Sling Capacity Ratings at Work Load Limits in pounds (WLL) Do Not Exceed WLL

Dia. inch	Dia. mm	Circ. inch	MBL lbs	Min OAL in ft	Min Eye Size in inches	Plasma® 12-Strand	
						Vertical	Basket
1/4	6	3/4	6,400	4	6	1,280	2,560
5/16	8	15/16	9,360	4	6	1,872	3,744
3/8	9	1-1/8	14,000	5	6	2,800	5,600
7/16	11	1-1/4	16,800	6	6	3,360	6,720
1/2	12	1-1/2	25,040	6	6	5,008	10,016
9/16	14	1-3/4	30,320	7	6	6,064	12,128
5/8	16	2	41,120	7	6	8,224	16,448
3/4	18	2-1/4	54,800	8	6	10,960	21,920
13/16	20	2-1/2	59,200	9	6	11,840	23,680
7/8	22	2-3/4	74,080	10	6	14,816	29,632
1	24	3	88,000	11	8	17,600	35,200
1-1/16	26	3-1/4	103,360	12	8	20,672	41,334
1-1/8	28	3-1/2	117,600	12	8	23,520	47,040
1-1/4	30	3-3/4	132,000	13	8	26,400	52,800
1-5/16	32	4	156,800	14	8	31,360	62,720
1-1/2	36	4-1/2	176,800	16	8	35,360	70,720
						Plasma 12x12	
1-5/8	40	5	232,800	18	12	46,560	93,120
1-3/4	44	5-1/2	251,200	20	12	50,240	100,480
2	48	6	284,000	21	12	56,800	113,600
2-1/8	52	6-1/2	342,400	23	12	68,480	136,960
2-1/4	56	7	384,800	26	12	76,960	153,920
2-1/2	60	7-1/2	424,000	27	12	84,800	169,600
2-5/8	64	8	476,800	27	12	95,360	190,720
2-3/4	68	8-1/2	528,000	28	12	105,600	211,200
3	72	9	624,000	30	12	124,800	249,600
3-1/8	76	9-1/2	680,000	32	18	136,000	272,000
3-1/4	80	10	752,000	34	18	150,400	300,800
3-1/2	84	10-1/2	886,400	36	18	177,280	354,560
3-5/8	88	11	1,000,000	37	18	200,000	400,000
3-3/4	92	11-1/2	1,053,600	38	18	210,720	421,440
4	96	12	1,216,000	40	18	243,200	486,400



Extender™ slings are adjustable to allow use in a variety of applications; they feature one permanent eye and one adjustable eye

Extender™ slings must only be basketed in the slings' clear spans and never loaded on a spliced area. Extender slings must never be used in a choker configuration. This MBL includes a 20% reduction from traditional, non-adjustable Plasma Eye and Eye Slings due to efficiency losses in the adjustable splice. Minimum Break Load (MBL) in pounds is determined using spliced test samples in accordance with Cordage Institute 1500-02 - Test Method for Fiber Ropes. Specifications for Extender slings assume one fixed eye splice and one adjustable "pass through" splice. The length of the two splices determines the minimum length of the Extender Sling.

This design factor takes into account various factors including the use of Ultra High Molecular Weight Polyethylene (UHMWPE) fiber which is extremely durable and resistant to repeated high loads. The recommended Design Factor (DF) of 5:1 on this chart is based on several existing sling standards including ASME B30.9. Extender rope slings have and can be used with different DF ratios; however, this is a decision which must be made by a qualified person in conjunction with the rope manufacturer.

Refer to page 50 for effect of bending considerations.

Plasma® Rope Sling Rating Charts

Extender™ Slings Ratings – tonnes

Vertical



Basket



Sling Capacity Ratings at Work Load Limits in tonnes (WLL) Do Not Exceed WLL

Dia. inch	Dia. mm	Circ. inch	MBL tonnes	Min OAL in ft	Min Eye Size in inches	Plasma® 12-Strand	
						Vertical	Basket
1/4	6	3/4	3.0	1.2	152.4	0.6	1.2
5/16	8	15/16	4.0	1.2	152.4	0.8	1.7
3/8	9	1-1/8	6.5	1.5	152.4	1.3	2.5
7/16	11	1-1/4	7.5	1.8	152.4	1.5	3
1/2	12	1-1/2	11.5	1.8	152.4	2.3	4.5
9/16	14	1-3/4	14.0	2.1	152.4	2.8	5.5
5/8	16	2	18.5	2.1	152.4	3.7	7.5
3/4	18	2-1/4	25.0	2.4	152.4	5.0	9.9
13/16	20	2-1/2	27.0	2.7	152.4	5.4	10.7
7/8	22	2-3/4	33.5	3	152.4	6.7	13.4
1	24	3	40.0	3.4	203.2	8.0	16
1-1/16	26	3-1/4	47.0	3.7	203.2	9.4	18.7
1-1/8	28	3-1/2	53.5	3.7	203.2	10.7	21.3
1-1/4	30	3-3/4	60.0	4	203.2	12.0	23.9
1-5/16	32	4	71.0	4.3	203.2	14.2	28.4
1-1/2	36	4-1/2	80.0	4.9	203.2	16.0	32.1
						Plasma 12x12	
1-5/8	40	5	105.5	5.5	304.8	21.1	42.2
1-3/4	44	5-1/2	114.0	6.1	304.8	22.8	45.6
2	48	6	129.0	6.4	304.8	25.8	51.5
2-1/8	52	6-1/2	155.5	7	304.8	31.1	62.1
2-1/4	56	7	174.5	7.9	304.8	34.9	69.8
2-1/2	60	7-1/2	192.5	8.2	304.8	38.5	76.9
2-5/8	64	8	216.5	8.2	304.8	43.3	86.5
2-3/4	68	8-1/2	239.5	8.5	304.8	47.9	95.8
3	72	9	283.0	9.1	304.8	56.6	113.2
3-1/8	76	9-1/2	308.5	9.8	457.2	61.7	123.4
3-1/4	80	10	341.0	10.4	457.2	68.2	136.4
3-1/2	84	10-1/2	402.0	11	457.2	80.4	160.8
3-5/8	88	11	453.5	11.3	457.2	90.7	181.4
3-3/4	92	11-1/2	478.0	11.6	457.2	95.6	191.2
4	96	12	551.5	12.2	457.2	110.3	220.6



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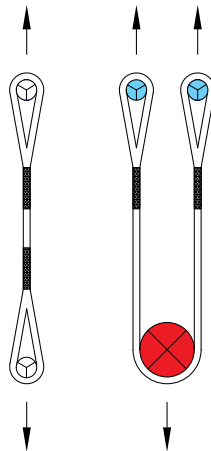
Refer to page 50 for effect of bending considerations.



Extender™ Sling Bending Guidance

In theory, a sling used in a basket configuration could have twice the working load as a sling in a vertical configuration because there are double the number of supporting strands. However, the decrease in tensile stress is partially offset by an increase in bending stress. The magnitude of this bending stress is dependent on the size and shape of the contact surface. Users must account for the bending strength loss with an efficiency factor as shown below in the Reduced Basket Capacity Calculation.

The bending efficiency reduces as the D:d ratio is reduced. Example: using an Extender Sling, a 3:1 D:d ratio provides 94% efficiency.

Reduced Basket Capacity Calculation
$C = B \times e$
C = Reduced Basket Capacity due to bending efficiency reduction
B = Rated Basket Capacity with consideration of horizontal sling fleet angle
e = Bending efficiency percentage



-  Represents a contact surface that is equal to or greater than the rope diameter
-  Represents a contact surface with a D:d ratio of one or greater. Refer to the Efficiency Table for deductions as needed.

Efficiency Table	
D:d Ratio	eff % (e)
5:1	100.0%
3:1	94.0%
2:1	91%
1:1	81%

Cortland International operates the world's largest synthetic rope manufacturing organization with capacity to produce over 70,000 metric tons of rope and netting solutions per year. Collaborating with customers, our team uses its experience in high-performance materials and market knowledge to transform ideas into proven products.

For more than 40 years, our custom-built solutions have been engineered to perform in the toughest environments and tackle some of the world's most demanding challenges. Trusted across aquaculture, marine and shipping, offshore energy, aerospace, defense and industrial sectors, they consistently empower our customers to meet and exceed mission-critical demands.

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