Technical Literature

Plasma® 12x12 Sling Inspection Guidelines

CORTLAND®

Lifting Slings Made From Plasma® 12x12 Ropes

Plasma® 12x12 ropes are excellent lightweight lifting tools providing reliable, safe and cost-efficient alternatives to traditional wire rope slings. When properly selected to meet the job requirements, e.g. strength, lengths, chafe protection, etc, and if used within Work Load Limit (WLL) standards, they can provide consistent performance over many safe and reliable lifts.

For information on selection, use and care of Plasma® 12x12 ropes slings please refer to the Plasma® Rope Sling – Selection, Usage and Care Guidelines.

The intention of this publication is to provide a visual and verbal inspection guide to rope sling users. The information is specific to Plasma® rope slings, not all synthetic rope slings. The process of selection, use and inspection/retirement of using Plasma® 12 strand or 12x12 rope slings, is a serious subject. Anytime a rope or sling is handled and used in a lifting operation the potential for damage and injury is possible. Cortland always recommends the following:

1. Adherence to any certification standards on slings and their use as determined by the end-user for the job; e.g. ASME B30.9 and others
2. Training of all personnel who use the products; selection, sling properties, effects of environment, rigging practices and inspection/retirement guidelines

Rope slings such as Plasma® 12x12 will not perform exactly like wire rope slings in use. Synthetic ropes, while offering weight and strength advantages typically will be less rigid in construction and more flexible. They are also not constructed using wire rope design guidelines. Therefore, use of wire rope inspection guidelines on synthetic rope slings is not recommended. Because of this difference a careful review of Plasma® 12x12 inspection and retirement guidelines is very important for safe use.

Plasma® 12x12 Ropes
Plasma® 12x12 HMPE (High Modulus PolyEthylene) fiber rope slings are produced in a torque-free braided construction. Plasma® 12x12 is a 12-strand rope in which each of the strands is, in turn, a 12-strand construction made with Cortland's Plasma® fiber.

Rope Construction

New section of Plasma® 12x12

Plasma® rope yarn

Plasma® rope strand
(12 strand construction)

Rope Construction cont.
Plasma® 12x12 rope slings are offered in two basic sling fabrications; single leg eye-and-eye sling and an endless grommet sling. In both slings, manufacturer specified end or eye termination splices are installed to provide safe and reliable performance. In a vertical lift operation, a new endless grommet sling is rated by Cortland at 1.65 times the new rope sling strength of an eye-to-eye sling. The choice of which sling fabrication is appropriate to a lift is the decision by the end-user designated person of responsibility, typically the lifting engineer.

Figure 2: single leg eye-and-eye sling

- Recommended D:d ratio of eye size is 3:1
- Tapered area from the “base” of the eye splice to the end of last tuck reduces from approximately 1.5 times the original rope O.D. to the nominal size
- Area or clear span between the bases of tapered tuck splices is recommended (see Rope Sling Manual for details)
- Cortland’s approved eye splice is the Moran 5/4/3 tuck splice
- MBL rating of eye-and-eye Plasma® rope sling includes splice and does not require further reduction in a vertical pull

Moran 5/4/3 Tuck Splice
close up of tails and tuck
area below eye splice

Figure 3: endless grommet sling with end-to-end splice

- Typical endless grommet rope sling has one end-to-end splice on one side only
- Eyes are typically formed by lashings. Plasma® endless grommets can be lashed together in selected areas (e.g. every 2M) for ease of rigging/handling
- Size of the middle of the end-to-end splice is typically 1.5 times the single leg O.D.
- Cortland approved end-to-end splice is Moran 5/4/3 tuck splice

Frequent and Periodic Inspection

It is highly recommended that a thorough inspection of all new, modified or repaired Plasma® 12x12 rope slings be conducted by a qualified responsible person before use. The person must have knowledge, training and experience of safe lifting operations & tools.

Because of the large variety of lifting uses Plasma® 12x12 rope slings are subjected to, it is also recommended to use a conservative approach to evaluation. Residual strength in a rope is subject to many considerations and a visual inspection can only provide a subjective estimate on retained strength. Without residual destructive testing backed by lifting history, a rope sling inspector can only provide estimates of its viability for future use through careful visual inspection and evaluation.

The following inspection information is designed to ensure the safe and reliable use of a Cortland sling. (It is partially or derived from the ASME B30.9-2006, Chapter 9-4 – Synthetic Rope Slings: Selection, Use and Maintenance standard and US Cordage Institute International Guideline, CI 2001-04 First Edition, Fiber Rope Inspection and Retirement Criteria).

Frequency of inspection
Visual inspection of sling by user or designated person each day or shift the sling is used. If the sling shows damage or is questionable in appearance, it should be removed from service until approved by a qualified person.

Periodic inspection
A designated person should perform a complete inspection on the sling at least once a year. This inspection should cover the entire length of the sling including splices, end termination hardware, chafe gear and fittings.

A. More frequent inspections by a designated person may be warranted if the following conditions are prevalent
    1. Severity of service conditions
    2. Complexity and nature of lifts being made
    3. Frequency of use
    4. Previous experience gained in the service life of the sling used in similar circumstances
B. A program of inspection procedures and record-keeping is recommended

Methods of inspection:

Lay out line or sling for thorough visual inspection

Used Plasma® 12x12 with protruding splice tails intact

Methods of inspection cont.

Visual inspection for construction changes, excess twist in rope

Inspect for excess surface wear on rope

Inspect to make sure certification tagging is intact and readable

Inspection of hollow core area of Plasma® 12x12 rope. In picture above, no internal wear is observed. Exterior yarn abrasion is noted as “light” and not a problem

Visual inspection of interior yarns shows wear from abrasion or cutting

Visual inspection of yarns on rope in this sample shows heavy cutting on two adjacent strands, but only moderate surface abrasion (darker areas on the surface of the strands)

Inspection Procedures

The following list is recommended for the user or inspector on Plasma® rope slings.

1. Entire length of sling should be laid flat, under hand tension, on smooth surface for visual inspection
2. Inspection of tagging integrity and legibility of information on the tag must be conducted
3. Visual inspection must be conducted with the following key items evaluated; potential areas of concern should be marked or tagged for further inspection
   A. Quality and condition of rope splice terminations
   B. Condition of external chafe gear protective coverings
   C. Condition of related hardware; e.g. thimbles
   D. Kinks, excessive twist or distortion of rope construction; e.g. variations in “pick” or braid helix angle within the rope length, or stiffness
   E. Abrasion wear on surface yarns, strands and entire body of rope. Also inspect for integrity of internal fibers and yarns
   F. Cuts to yarns and strands
   G. Reduction in overall diameter of rope possibly caused by
      - Overloading
      - Excessive abrasion
      - Compression and compaction
      - Excessive sustained heat causing creep (cold flow)
   H. Damage caused by external or friction heat; fiber melting
      - Discoloration
   I. Chemical contamination

Inspection Points Pertinent to Plasma® 12x12 Rope Slings

Quality of Splice: Cortland uses a Moran 5/4/3 tuck splice procedure to make Plasma® 12x12 splice terminations. The splice consists of a short buried section at the base of the eye, followed by a series of tucks that pass over and under strands in the body of the rope.

Splice tails are secured with tape or material to retain a “new look” when originally spliced. However, during handling and use, the tape or covering can wear away allowing the ends of the tucking strands to become loose or frayed. This should not be a worry and will not affect splice integrity. These tucks and buried areas provide the strength rating for the rope sling and therefore their integrity is of primary importance. Splice terminations can be repaired with re-splicing performed by an authorized trained splicer. A proper “re-splice” will offer 100% of the remaining strength of the rope sling.

Inspection Points

Quality of Splice cont.

Moran 5/4/3 tuck splice Plasma® 12x12 – which is spectacle-spliced into a pendant. Note exposed “tails” on Moran 5/4/3 splice

Used piece of Plasma® 12x12 line with abrasion wear on splice area. Note the exposed “tails” which no longer have tape securing the ends. This is an example of a used “floppy” tail

Standard eye chafe protection gear on Plasma® 12x12 slings is Cortland’s SX coated braid, which offers the high abrasion and cut resistance of HMPE fiber combined with light weight and no water absorption. Some customers may opt for other chafe protective coverings such as JHRG woven HMPE fabric gear, or Cordura® sleeves. These protective sleeves are designed to extend the service life of a sling by mitigating abrasion, cutting, and heat damage. All Cortland chafe sleeve options do not contribute to the rated rope sling strength. Therefore, they can be replaced when cut, torn or worn. During sling inspection, cover chafe protection should be pulled back or removed to allow visual inspection of the rope strength member.

Distortion of Rope Construction

Plasma® 12x12 rope slings are manufactured with balanced yarn and strand construction. Distorted and/or damaged yarns and strands usually occur in most applications. Ropes exhibiting areas of severely distorted construction or yarn damage should be repaired or retired from service.

It is also very important that the operators attempt to determine what caused or continues to cause rope construction distortion or yarn damage in the application. It is likely that modifications in hardware, handling or use of the Plasma® rope may mitigate or eliminate future problems.

Distortion of Rope Construction cont.

Unequal loading, overloading, shock loading, “pinching” or contact with angled surfaces may cause distortion to the original construction of the rope. Inspection of the rope sling to investigate possible areas of construction distortion should look for two main areas:

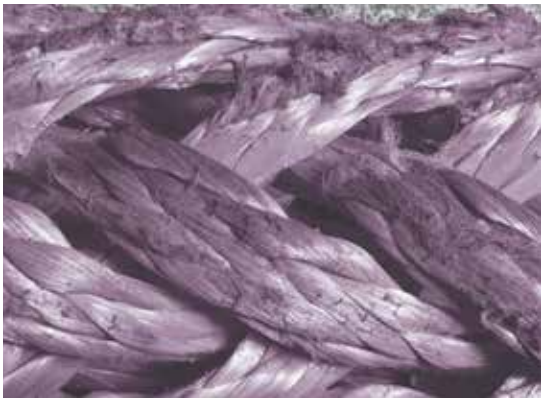
1. Twisted strands within the braid length
   A. These strands exhibiting twist should be repaired or the sling should be removed from service
2. Visual changes in “pick” or helix braid angle of the braid
   A. Measuring the areas of suspected deviation in pick angle should take place. These areas should exhibit no more than +/- 5% overall rope length.

Rope distortion may also be an example of creep or cold flow. This is permanent elongation of the fiber and rope. Creep rates depend on the type of material, time, temperature and load relative to breaking strength.

1. Creep is typically not a factor with HMPE rope slings unless long sustained high loads are in effect.
2. Ropes that fail due to creep often retain relatively high strength 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, high modulus synthetic fibers will not exhibit creep over the normal course of operations.**

Abrasion Wear

Normal low exterior wear; “fuzziness”



Normal low exterior wear; fuzziness but no cut strands

While HMPE is one of the most cut-resistant synthetic fibers available, metal can prove to be stronger than Plasma® in a long duration abrasion event. Signs of excess abrasion include strand pull-outs, heavy fuzzing, cut strands in a single area, and localized bunching. It should be noted that normal light fuzzing of the Plasma® rope surface is to be expected in normal use. This light fuzzing does not reduce the rated strength of the line, and actually creates a protective layer on the surface of the rope that helps to prevent further damage.

Inspection methods for abrasion should include the following:

Exterior inspections

1. Measure the outside diameter of strands that exhibit abrasion that appears excessive. These strands should not have other damage, such as cutting, that would further affect the strength.
2. Look for broken exterior yarns
   A. Broken exterior yarns can be caused by normal abrasion, wear against rough or angled surfaces, and environmental exposure to chemicals or sunlight (UV).
   B. Note the type, location and level of damage such as number of broken or noticeably damaged yarns, depth and length of abrasion or wear spots, frequency and spacing of damage, if damage is one strand or multiple strands.
3. Estimate the loss of strength by comparing abraded or cut fibers as a percentage of the rope or undamaged strand diameter.

Inspection Points

Interior abrasion inspection

1. Open the rope construction to view internal yarns and strands
   A. Note – Plasma® ropes include a water-based urethane coating to provide abrasion resistance. This coating may lose pigmentation over time and appear lighter in color.
2. Check for the ingress of dirt and particulate matter as well as fluids; e.g. oil or grease.
   A. These items may cause internal abrasion and a determination of future use must be made. Note – the rope can be washed (cleaned) with fresh water if necessary.
   B. Powdery areas or fused yarns internally are probably caused by excessive cycle loading, overloading and/or internal yarn against yarn abrasion. A rope exhibiting these conditions should be retired.

Excessive **exterior** abrasion wear

Excessive **interior** abrasion wear

If the original size or volume of a Plasma® 12x12 rope sling appears to have been reduced by 25% or more either locally or over it's entire length, the rope sling must be retired from service.

Cut or Snagged Yarns and Strands

Repeated lateral abrasion wear against sharp edges can cause the primary type of damage to Plasma® 12x12 rope slings; cut yarn and strands. Partial cutting of yarns and/or strands can create an imbalance in load-sharing, leading to significantly lower strength.

Cut adjacent strands; from its look it may have been cut by a "crossing" wire rope

Cut adjacent strands probably caused by rubbing against a sharp corner or edge of metal

Cut or Snagged Yarns and Strands cont.
As a general rule of thumb during inspection:

1. Cut yarns do not have as much impact as cut strands; however, all cuts should be thoroughly inspected to determine the severity of the cut.
2. While cut rope yarns may be a problem, a cut strand is a larger issue for rope integrity
3. One strand cut 50% or more is cause for retirement
   A. Plasma® 12x12 constructions may be repaired through a strand splice. Proper re-splicing by an authorized individual is required. A 12x12 rope with a strand re-splice should be down-graded in strength by at least 15%

Non chafe protected areas of Plasma® 12x12 may exhibit a yarn or strand snag. A snagged yarn or strand 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.

Overall Diameter; Changes to Original Size and Construction of Rope

Unlike relatively rigid wire rope constructions, Plasma® 12x12 rope slings may change shape when under load or bent, against contact surfaces. Synthetic fiber ropes can change shape; however this typically should not be a reason to discard the sling unless the change of shape is permanent and detrimental to strength rating and performance.

New, non-proof loaded or relaxed (in storage), Plasma® 12x12 slings may exhibit outside diameters larger than published nominal sizes. Under load, these ropes will reduce size to proper O.D.

Under normal loading while not compressed against rigid surfaces, a Plasma® 12x12 rope sling will form a round or slightly oval outside diameter. When not under load, a pinched or compressed area of the rope can usually be "worked" or hand-flexed back into it's original shape. Areas of the rope sling that cannot be worked or hand-flexed back into original shape and size, may be an indication of several factors including overloading, excessive cycle-loading, and yarn or strand fusion. These slings must be retired from service.

Overall Diameter Size; Changes to Original Size and Construction of Rope

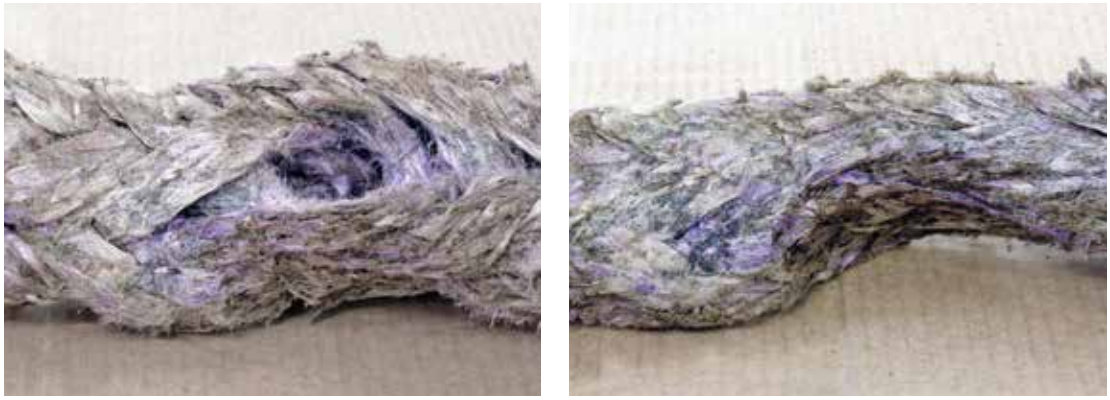
Excessive abrasion wear – volume of total rope in selected area is substantially reduced

Severe case of compression and construction distortion. Typically this occurs on the bottom layer of a Plasma® winch line compressed against its barrel or flange. If this occurs it is recommended that the severely compressed/ distorted area be cut out before further use.

Excessive abrasion wear – volume of total rope in selected area is substantially reduced

Inspection Points

Heat Damage
Each synthetic fiber has a critical temperature at which it softens permanently, affecting the initial fiber properties, particularly strength and elongation. Plasma® is a high modulus polyethylene fiber. It will gradually begin to lose strength at temperatures above approximately 65°C/150° F. HMPE has a zero-strength temperature around 150°C/297°F. **Long term exposure above 60°C/140°F is not recommended.**



Heat damage on Plasma® rope likely caused by friction heat or slippage. Cover yarns are glazed and fused together. Inspection of the core of the rope on left also shows internal heat. Rope area must cut out or rope retired from service.

Users of Plasma® rope slings need to be aware of high ambient, reflected heat or friction heat in applications, as well as proximity to localized heat sources such as flame or welding that could damage the sling. If it is anticipated that heat will be an issue in the use of a Plasma® lifting sling, care should be taken to protect the rope from high temperatures if at all possible. If this is not possible, the may be necessary to use an alternative high modulus synthetic fiber, such as an aramid, that is more heat resistant.

1. The size and mass of ropes in larger diameters, e.g. 30mm +, may mitigate the effect of heat as it is difficult to transfer exterior heat into the interior of the rope. Typically, the center of a Plasma® rope does not experience heat damage in normal applications.
2. Signs of temperature damage include melting, fused strands and significantly reduced diameter. The fused strands should not be confused with fiber that has been tightly compacted or compressed while under load.

Inspection Points

Discoloration
Localized or extended areas of discoloration on Plasma® 12x12 rope slings may be a cause for retirement if they are caused by chemical contamination or excessive build-up of dirt, grease or oil-type fluids. (Please see Cortland Plasma® 12x12 Rope Sling Selection and Use guidelines for a full chart of damaging chemicals).

Heavily discolored Plasma® rope from mud, dirt and fluids. Interior is checked to insure no internal yarn damage.

Rope slings should be inspected for localized areas of:
1. Inflexibility
2. Yarn brittleness, abrasion wear or deterioration
3. Discoloration

In sling lifting applications where there is high potential for the ingress of sharp particulate matter or grit inside the rope, proper chafe protective wear material must be used. Internal yarn and strand cutting caused by grit and dirt in the rope can seriously lower the performance of the sling. If necessary, Plasma® rope slings can be washed; however it is recommended that only fresh water be used and not high pressurized mechanical cleaning. Washed ropes can be dried easily or used immediately.

Grease and oil deposits, of themselves, do not damage Plasma® rope slings. However, they can trap dirt and grit that may damage the rope during use or storage.

Repair

Repair of Plasma® 12x12 Ropes

A unique feature of Cortland's 12x12 construction is its ability to be repaired by replacing and re-splicing in a new replacement strand. While the original strength and balance of the rope construction will not be as perfect as in it's original production form, strand replacement is effective for repairing the rope sling when the process is deemed acceptable by a designated responsible person.

1. Re-splicing of Plasma® 12x12 rope for lifting sling operation must be conducted by an authorized person. Detailed strand re-splicing guidelines are available from Cortland.
2. Re-spliced Plasma® 12x12 rope slings must be newly tagged with required identification information per certification agency. Re-tagging is done by the repairing agency.
3. Knotting of Plasma® 12x12 rope slings is not allowed under any circumstances.

Recertification

Recertification and Use of Modified or Repaired Plasma® Rope Slings

The choice of re-using a Plasma® rope sling must be made after careful inspection and maintenance of the sling and a decision by a qualified person as to the suitability of the sling for use on another lift.

Plasma® rope slings have been successfully used on multiple project lifts, stored for several months or more, inspected, repaired, possibly modified in length, re-spliced and recertified after proof-loading. The Plasma® HMPE fiber has excellent long-term fiber fatigue resistance properties and the majority of rope slings used at or below customer selected or classification society certified WLL, have several years of usual service life and performance. The following scheduled list is highly recommended to end-users seeking future use of Plasma® rope slings.

Retirement

Retirement Criteria

A summary guide for retirement of Plasma® 12x12 rope slings is offered below. Plasma® 12x12 rope slings meeting any one of the listed criteria, and not being able to be repaired or used after repair should be immediately retired from future use.

Performance properties, such as strength and length tolerances, that are altered or modified after sling repair may disallow the particular repaired sling from service in lifting. Safe rigging practices using used or repaired slings are the responsibility of the responsible qualified person for the lift.

	Condition	Retire
1	**Tagging illegible or missing**	✓
2	**Rope splice integrity damaged; e.g. tucks pulled out**	✓
3	**Distortion of construction / Diameter inconsistency**	✓
5	**Internal abrasion** Melted or fused yarns and strands Powdery or brittle fibres	✓
6	**Cuts (fiber, yarn and strands)** Two (2) or more cut adjacent yarns in a strand One cut strand	✓
7	**Reduction in overall diameter of rope** Localized diameter area reduction Stiff and flat areas on rope unable to be flexed back into shape	✓
8	**Heat damage** Localized areas of fused and melted fibres	✓
9	**Discoloration caused by unknown source** Localized areas that “cleaning” cannot repair	✓

Notes

Notes

Cortland is a global designer, manufacturer, and supplier of technologically advanced ropes, slings, and strength members. Collaborating with customers, our team uses its experience in high performance materials and market knowledge to transform ideas into proven products.

For more than 35 years, our custom-built solutions have been developed for work in the toughest environments and to overcome some of the world's greatest challenges. They consistently enable our customers to meet the demands of the aerospace, defense, medical, research, subsea, marine, and energy industries.

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