PO. 074

# Decommissioning & Installation of Wind Energy Equipment with Synthetic Sling Solutions


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SAMSON


THE STRONGEST NAME IN ROPE

## ABSTRACT


In today's energy market, the days of decommissioning older wind structures are approaching. Whether equipment is removed from existing sites or rebuilt to incorporate improvements in technology, efficient lifting solutions are required.

High-performance fibers such as High Modulus Polyethylene (HMPE) are utilized frequently for engineered critical lifts across multiple industries. Awareness of the high strength, durability, and ease of rigging that synthetic solutions provide is increasingly common. It is normal for industry experts to integrate these benefits when installing subsea and topside structures.

To identify ideal solutions in demanding rigging operations, engineers and lift planners must understand the details of intended use during the operation. Design of specific lifting solutions can vary widely based on a range of factors — frequency and number of lifts to be performed, length tolerance requirements for matched rigging, potential dynamic scenarios, as well as integration of mating hardware and equipment.


## OBJECTIVES

The purpose of the presentation is to compare and contrast available solutions for the rigging application of engineered lifts, including traditional single-leg, grommet, and new multiple-loop sling options.

## METHODS

Most of our slings are made of 12-strand braided rope construction made of HMPE fiber (i.e. AmSteel-Blue). Samson uses HMPE for engineered lifting slings based on its durability, demonstrated through historical usage data.

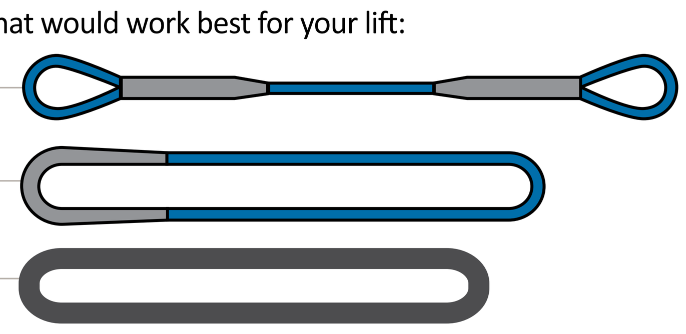
### DEFINE APPLICATION PARAMETERS:

**1. WORKING LENGTH** The distance between two extreme end bearing points of the sling under working conditions. High-performance rope will experience initial elongation when the sling is put in service or proof loaded. Thus, many sling manufacturers offer pre-stretching to stabilize length and remove initial elongation to achieve the working length required. Acceptable length tolerance should be specified by the customer, especially when multiple rope slings will be used at the same time. Typically, when rope slings are fabricated as matched sets, tighter tolerances are achievable. More importantly, with the help of mechanical devices to fabricate round slings, we achieve closer length tolerances when compared to hand-spliced rope.

**2. MINIMUM BREAKING STRENGTH (MBS)** Required sling breaking strength. The MBS is derived from break load data testing of the rope or the sling.

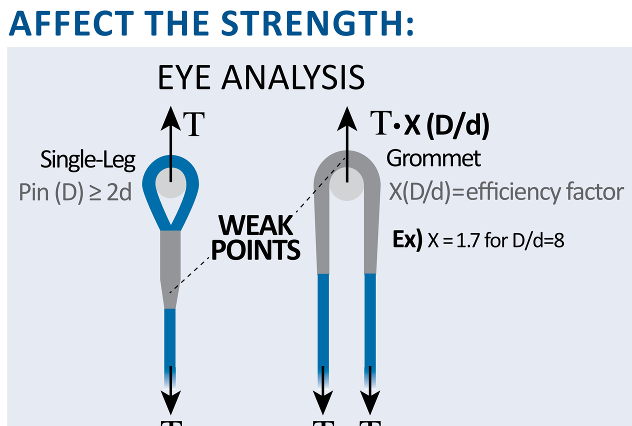
**3. SAFE WORKING LOAD = MBS / FOS** The maximum load that the sling is certified to lift under normal conditions in a given configuration. The factor of safety (FoS) required for the engineered lift, along with the load, is used to establish the safe working load of the system. This FoS is supplied by the customer based on their application, but it is recommended that it be calculated using a recognized industry lifting standard such as DNV GL Offshore DNV-OS-H205.

Choose the type of rope sling that would work best for your lift:




### EXTERNAL FACTORS THAT AFFECT THE STRENGTH:

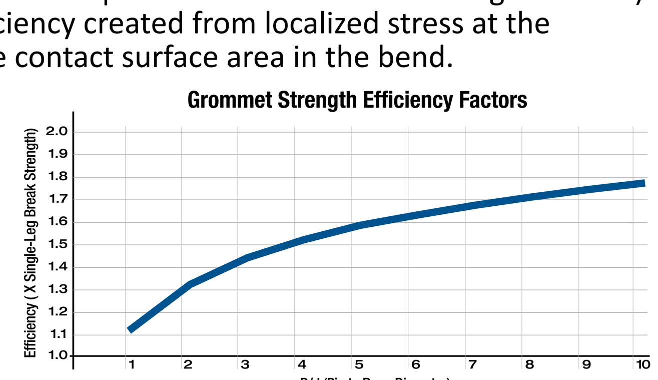
**1. BENDING LOSSES** The amount of strength loss due to bending on a rope sling depends on the fiber type, configuration and coating. Critically, bend loss efficiency depends on the construction of the sling (type) and pin diameter. For single-leg eye slings, pin diameter must be at least twice the rope diameter to protect against pinching and ensure full strength efficiency.

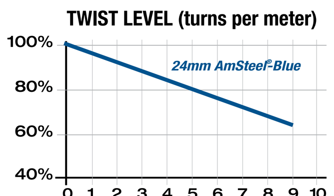



A grommet load carrying ability (i.e. its MBS) will be more significantly impacted by the size of the bearing surface (i.e. the D/d) due to the localized load zone being concentrated at the back of the pin.

Bend loss efficiency serves as a critical point for endless loop slings. Enlarging the D/d ratio, (where D is the pin diameter and d is the sling diameter) compensates for the loss of efficiency created from localized stress at the back of the pin by increasing the contact surface area in the bend.

To maintain 100% strength efficiency, minimum D/d of 2 is recommended for single-leg eye. Grommet strength efficiency can range from 1.15 to 1.8 times the single-leg break strength, as shown:



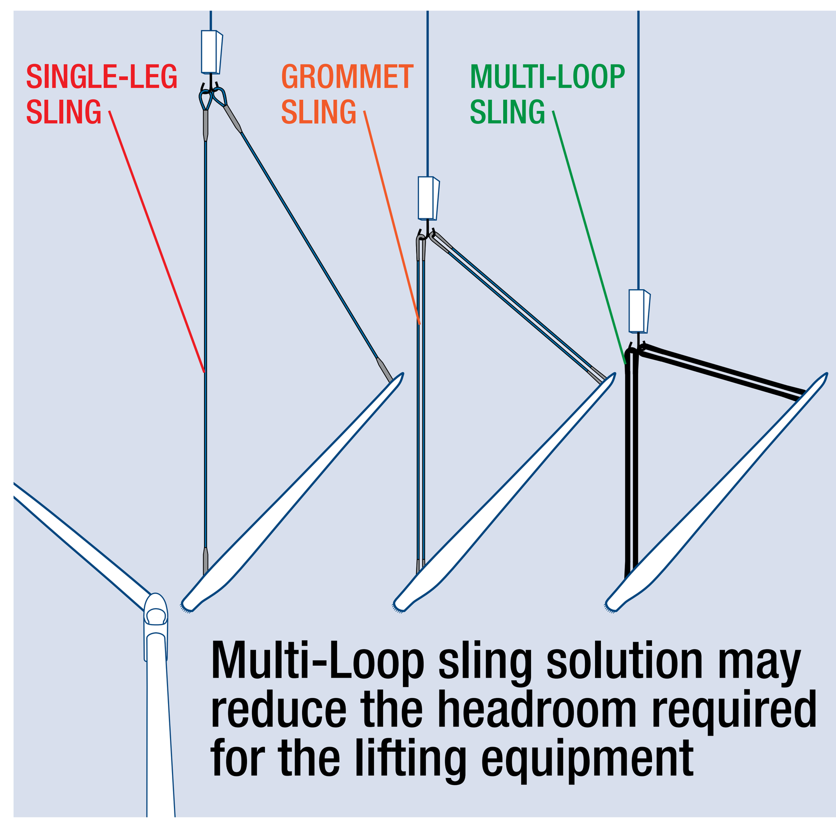

**2. TWIST** Rope strength decreases with the amount of twist induced. The effect of twist varies with sling length, construction, configuration and diameter.

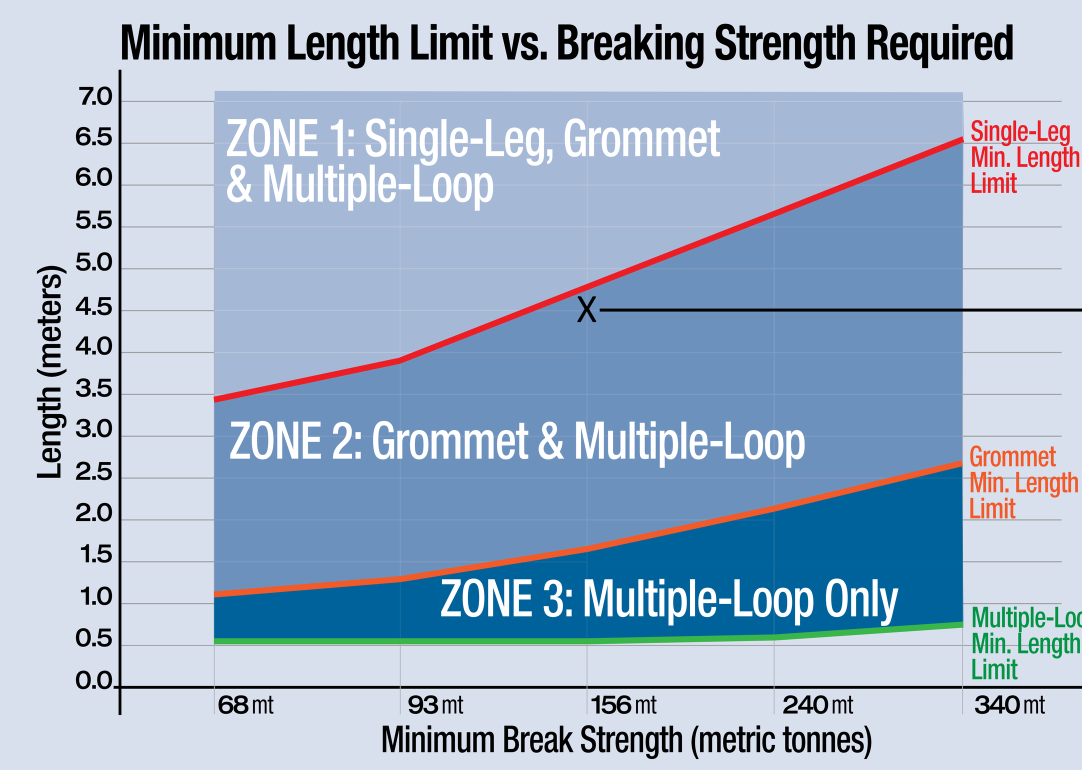
**3. ABRASION** Synthetic slings can be damaged more easily than slings made of steel, thus careful consideration must be given to the level of protection required, especially when the load bearing member is exposed to contact surfaces constantly. Protection material can be applied at bearing points to prevent failure due to abrasion—either permanently fixed or movable—depending on the application needs.

**4. INSPECTION/RETIREMENT** Engineered lifting slings are to be inspected before and after use. It is also advisable to do a thorough inspection daily or weekly or to retire periodically. Samson has a visual inspection program in place to help make critical field inspections a simple matter of comparing conditions to a visual standard.

*The visual comparator, above, allows comparison of both internal and external abrasion and indicates a general assessment of the rope's residual strength.*

## RESULTS



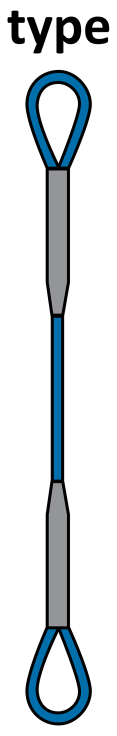




### LIFTS IN ZONE 3 CAN BE MANAGED WITH A MULTIPLE-LOOP SOLUTION

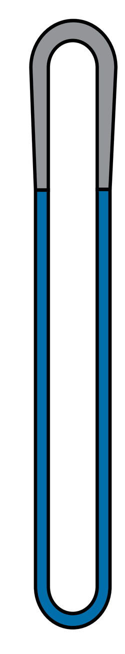
PROJECT X requires a 4.5m sling with 156 mt minimum break strength. If you look at a linear line of 4.5m, the dot would fall onto Zone 2 "Grommet & Multiple-Loop" (which indicates only those two options are available) as the minimum length to make a Single-Leg eye sling would be close to 5m.

### PRODUCT DESIGN COMPARISON

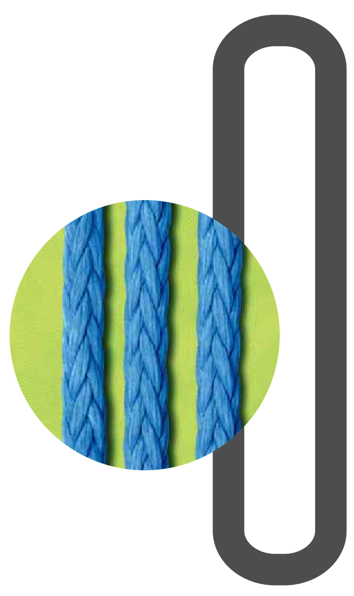
**Design factors, parameters' impact and resulting limitation, and efficiency indicators for each product type are summarized here:**



| SINGLE-LEG + |
|---|
| Ability to handle tightest bend radius (D/d) |
| Highest fiber efficiency (Strength per length)[2] |
| **SINGLE-LEG −** |
| Most limited short length |
| Longest lead time on bigger rope diameter |



| GROMMET + |
|---|
| Smaller bearing point[3] |
| **GROMMET −** |
| Highest strength reduction on bend loss (D/d) |
| Lower fiber efficiency (strength per length)[1] |



| MULTIPLE-LOOP + |
|---|
| Shortest length possible |
| Less D/d effect as individual rope d is considered not total width of ropes |
| Tightest length tolerance |
| Less localized contact pressure |
| **MULTIPLE-LOOP −** |
| Higher strength reduction on bend loss (D/d)[2] |
| Bigger bearing point |

*NOTES: 1 when compared to Single-Leg option, 2 when compared to Grommet option, 3 when compared to Multiple-Loop option*

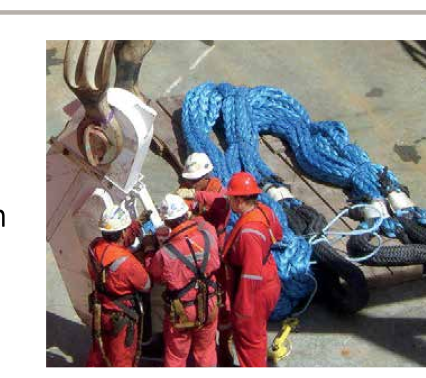
### APPLICATION CASE STUDIES

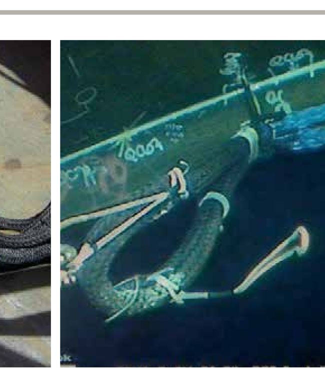
**MONOPILES INSTALLATION FOR OFFSHORE WIND FARM IN NORTH SEA**

This project involved the installation of 140 turbine foundation monopiles. A working set and a backup set of slings were fabricated from Samson's 152mm diameter *AmSteel®Blue*, each set included two single-leg eye slings and one grommet. The monopiles weighed up to 676mt. Chafe protection was applied to all weight-bearing points. When the project was completed successfully, the slings were closely examined for wear and damage, and it was determined that there was no sign of damage and the working set could be commissioned again for future use.

**CONDUCTOR PIPELINES INSTALLATION IN BRAZIL —OFFSHORE FOR DEEP WATER DRILLING**

The deployment of conductor pipes from barge to seabed was done with just two single-leg eye slings, fabricated from Samson's 120mm diameter *AmSteel®Blue*. This validates the point that the task could be done without the aid of a drillship or rig, and could not possibly have been done with traditional steel slings as they were too heavy and difficult to work on this application.





**INSTALLATION OF SUBSEA PUMP STATION IN THE GULF OF MEXICO**

First use of an FPSO in U.S. waters: The *AmSteel®Blue* 88mm diameter single-leg eye was used as a "hand-off" sling. Due to water depth, the 400mt outboard crane could not reach bottom. Therefore, they used the crane to overboard the package, and lower it a hundred meters. Using ROVs, they then attached the *AmSteel®Blue* sling to a winch with a much higher capacity to lower the package to the sea floor. The *AmSteel®Blue* sling successfully managed the load all the way down—the "wet handshake" was complete.

## CONCLUSIONS

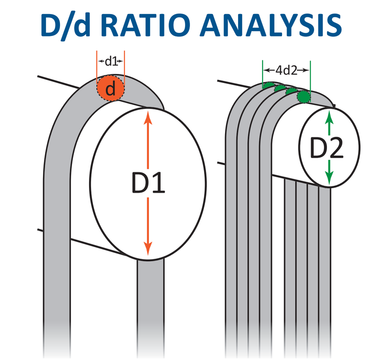
To conclude, there is no one-size-fits-all product designed for engineered lifts. Each specific lift calls for a sling designed for that operation, and each sling type has pros and cons depending on the job specification. Understanding the intent of the project in detail is critical.

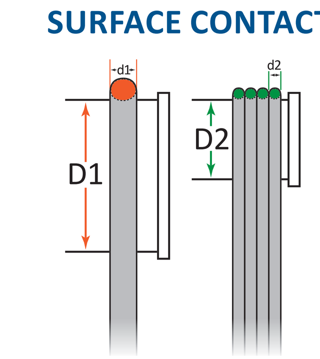
The multiple-loop product is designed for this very fit-for-purpose functionality. The benefits outweigh the negatives of the product to adapt to rigorous tasks in the ever-demanding engineered lifting industry. Using this product enables Samson to fabricate precisely engineered lifting slings with the following advantages:

- **Lighter weight for easy handling, cutting your overall rigging weight up to 80%**
- **Higher load capacity per length due to its multiple-loop configuration**
- **Shortest length for easy maneuverability between the crane hook and the object lifted, demonstrated in the chart, right**
- **Protective cover around the body of sling to minimize the risk of abrasion**
- **Easy inspection of the sling assembly for safety purposes**
- **Smaller D/d ratio possible, because the system interacts with individual ropes, while working as a series**
- **Tighter length tolerances: +/- 0.25%**
- **Less localized pressure area due to wider contact surface**
- **Faster lead time due to its ability to be built from available stock of multiple rope diameters**
- **Potentially multi-use, could be repurposed**

| TYPE | Max. Break Strength | Min. Length |
|---|---|---|
| Single-Leg | 1,800mt | 13.0m |
| Grommet SPLICE ON PIN | 3,060mt | 7.5m |
| Multiple-Loop | 4,000mt | 6.0m |

Summary of the maximum breaking strength limitation with its minimum length built is tabulated as above. These products have been tested both in the field as well as through empirical models based on fiber content.




It is important to note that D/d of multiple-loop is calculated based on the 'd' as individual rope, not the total width of the sling. Thus, as the 'd' gets smaller while maintaining constant pin diameter, the strength efficiency increases.

## REFERENCES


A. INDUSTRY STANDARD SLING DOCUMENTS
- *i. ASME B30.9*
- *ii. Cordage Institute CI 1905*
- *iii. IMCA M 187*

B. INDUSTRY GUIDANCE ON SAFETY FACTOR
- *i. DNV GL Offshore Standard DNV-OS-H205*

C. SAMSON DOCUMENTS
- *i. Samson Offshore Sling Brochure*
- *ii. AGILE Sling Brochure*
- *iii. Technical Bulletin on Inspection and Retirement Criteria Development*
- *iv. Technical Bulletin on The Effect of Twist on Braided Ropes*