

Synthetic Lifting Slings: Facts and Fiction

Presented by:
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samson
THE STRONGEST NAME IN ROPE

Agenda



- **Qualifications and corporate background**
- **Constructions designed for specific attributes**
- **Previous experience**
 - **Custom solutions for specific technical requirements**
- **Inspection & retirement**
- **Sling standards**
- **Sling considerations**
- **Heavy lift project**

Qualifications

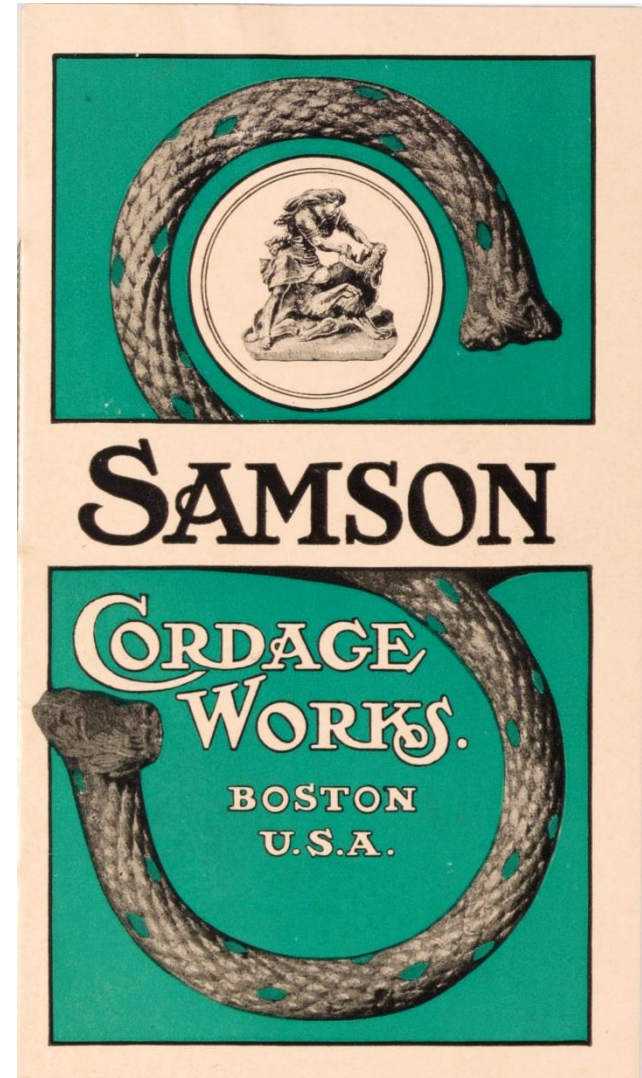


- **Bachelor of Science in Plastics Engineering Technology from Western Washington University**
- **Application Engineer with Samson since 2012**
- **MSHA art 48 certified**
- **Active ASME and SME member**

Corporate Background



- Founded in 1878 in Boston
- History of innovation
- Oldest active trademark in the U.S.
- Largest high performance rope producer in the world
- Headquarters in Ferndale, WA
- Manufacturing locations in Lafayette, LA and Ferndale
- 300 employees worldwide



History of Innovation



- **1884: 1st reinforced core sash cords**
- **1957: Invented the double braid**
- **1972: 1st synthetic offshore tanker mooring**
- **1996: 1st tanker fleet converted from wire (Chevron)**
- **2002: Highest strength synthetic rope size-for-size**
- **Patents**
 - **13 active patents on rope and associated technology**
 - **2003: DPX™ fiber technology**
 - **2004: Reduced recoil rope**
 - **2006: Heat-resistant rope**
 - **2008: Deep Cool technology (CBOS)**
 - **2011: Rope for contaminated marine environments**



Types of Rope



ROPE CONSTRUCTION



3-Strand



8-Strand



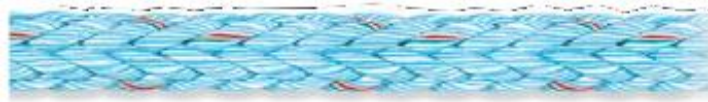
12-Strand



Double Braid



8x3-Strand



Round Plait



Core-Dependent

High-Performance Fibers



- **Variety of high-performance fibers**
 - HMPE (Dyneema®, Spectra®)
 - Aramid (Technora®, Kevlar®, Twaron®)
 - LCP (Vectran®)
 - PBO (Zylon®)
- **Increased anisotropic nature of fiber as compared to traditional fibers**
 - **Controlled drawing process to enhance molecular alignment**
 - **Increased tenacity**
 - **Reduced elongation**



Fiber Comparison



Fiber	Specific Gravity	Melting Temperature (°C)	Tenacity (gpd)	Elongation at Break (%)
Nylon	1.14	218° – 279°	7.5 – 10.5	15 – 28%
Polyester	1.38	254° – 260°	7.0 – 10.0	12 – 18%
Olefin	0.91 – 0.99	140° - 196°	6.0 – 7.5	12 – 24%
HMPE	0.97	144° – 155°	32 – 44*	2.8 – 3.9%
Aramid	1.39 – 1.47	Does not melt; Decomposes @ 500°C	18 – 29	1.5 – 4.6%
LCP	1.40	330°	23 – 29	3.3 – 3.6%
PBO	1.54 – 1.56	Does not melt; Decomposes @ 650°C	42	2.5 – 3.5%

**Specialty grades of this fiber also exist with higher tenacities*

- Specific Gravity:** Ratio of yarn density to that of water
- Tenacity:** Ratio of yarn strength per weight; tested per ASTM D885
- Elongation at Break:** Percent of length change; tested per ASTM D885

- **Dyneema®**
 - **High modulus polyethylene (ultra high molecular weight PE)**
 - **Positive buoyancy (floats, SG < 1)**
 - **Chemical resistant**
 - **Good UV resistance**
 - **Excellent flex fatigue characteristics**
 - **Low elongation (comparable to steel-wire rope)**
 - **10x stronger than steel pound-for-pound**
 - *Comparable strength size-for-size to wire*
 - *1/7th the weight of steel-wire rope*
 - **Low coefficient of friction (highly abrasion resistant)**

Environmental Considerations



▪ Temperature

- Do not use over 140°F
- Avoid high heat sources
- Avoid welding within 5 feet
- Synthetic fibers gain strength in cold temperatures



▪ Chemical

- Highly chemical inert
- Not affected by common acids, bases or oils

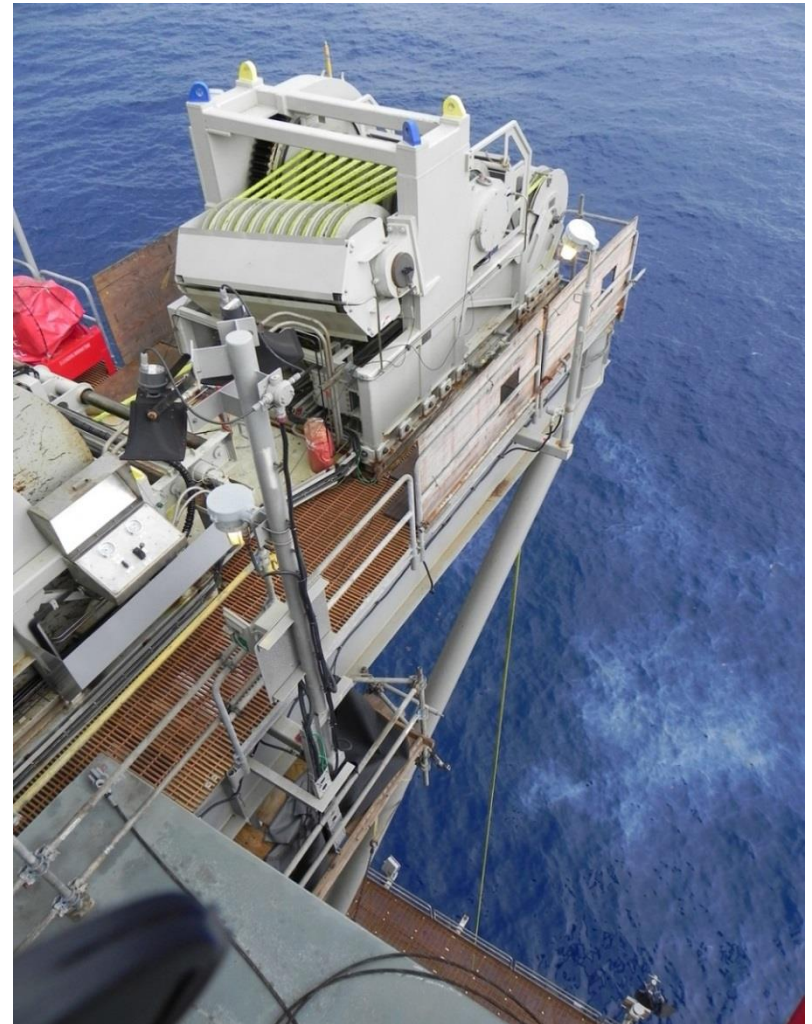
Chemical	Chemical Resistance (EFFECT ON FIBER TENSILE STRENGTH)
Acetic Acid	++
Acetone	++
Calcium Hydroxide	++*
Common Detergent	++
Ethanol	++
Hydrochloric Acid	++
Nitric Acid	++
Oil	++
Sodium Hydroxide	++*
Sulfuric Acid	++
Toluene	++
Water	++

** Tensile strength is significantly reduced (to --) as time and temperature are increased*

Custom Solutions for Specific Requirements



- **Shell's Perdido Spar Traction Winch**
- **World's deepest oil production facility**
 - **9,200' water depth**
 - **Onboard winch to reduce reliance on support vessels**
 - *Steel wire not viable*
 - **Quantum-12 solution**
 - *85% less weight*
 - *Neutral buoyancy*
 - *Patented DPX™ fiber technology*
 - Traction
 - Bend fatigue
 - *Complete rope and winch package*



Custom Solutions for Specific Requirements



- **TARDEC – USMC first light armored recon battalion**
- **Reduced weight**
 - 200 lb. wire rope replaced by 25 lb. Samson product
 - Less manpower required
- **Reduced risk to back, hands, and recoil**
- **Less personnel exposed to enemy during combat recover operations**
- **Improved duty cycle**
- [Full article](#)



Custom Solutions for Specific Requirements



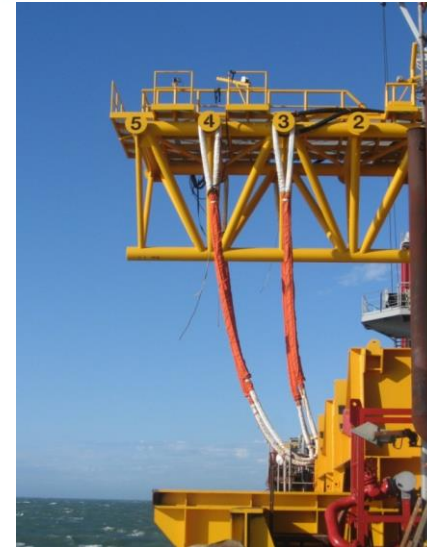
- **Alyeska Seafoods, Inc. F/V Sea Wolf Trawl Main Warp**
- **Weight savings / deck stability**
 - 4,500' of 1-1/8" rope
 - Steel wire would be 17,000 lbs. vs. 3,400 lbs. of synthetic
 - Improved handling/installation for crew
- **Spooling performance essential**
 - 10+ layers on winch
 - Rope construction designed with firm control core
 - Uneven spooling causes level wind issues
 - Inconsistent back tension can cause issues



Custom Solutions for Specific Requirements



- Seaway Heavy Lifting Greater Gabbard Wind Farm project construction
- 140 wind turbine monopiles installed using 2" AmSteel®-Blue slings
- Installation time reduced and safety increased due to ease of handling



Inspection & Retirement



■ Types of damage

CUT STRANDS *Any cut strands should be reported to a qualified person*



COMPRESSION *Visible sheen, stiffness reduced by flexing the rope, not to be confused with melting, often seen on winch drums*



PULLED STRAND *Strand pulled away from the rest of the rope, is not cut or otherwise damaged*



MELTED OR GLAZED FIBER *Fused fibers, visibly charred and melted fibers, yarns, and/or strands, extreme stiffness, unchanged by flexing*



Inspection & Retirement



- **Types of damage**

DISCOLORATION/DEGRADATION *Fused fibers, brittle fibers, stiffness*



INCONSISTENT DIAMETER *Flat areas, lumps or bumps*



ABRASION *Broken filaments and yarns*



Inspection & Retirement



▪ Abrasion measurement



▪ Visual comparison guide

- 1 million+ individual filaments per rope
- Operator can effectively rate level of rope wear

▪ Retirement or required action to be determined by qualified person based on:

- Internal/external abrasion level (higher than 3)
- Excessive twist in braided rope (greater than 2 turns/meter)
- Gross damage or deterioration of the end connections

Sling Standards



- **ASME B30.9 (American Society of Mechanical Engineers)**
 - Standard used most in North American slings
- **ISO NP 18624 (International Standards Organization)**
 - Under development
- **Governmental organizations (OSHA, MSHA)**
 - Relies on industry standards such as B30.9
- **Marine standards (DNV, Lloyd's, IMCA, OCIMF)**
 - Engineered lifts and project-based lifting

Sling Standards



▪ ASME B30.9

- Covers nylon and polyester rope
- Defers to manufacturer for other materials to provide specific data (9-4.2.4 Other Materials)
- Manufacturer is considered the sling fabricator

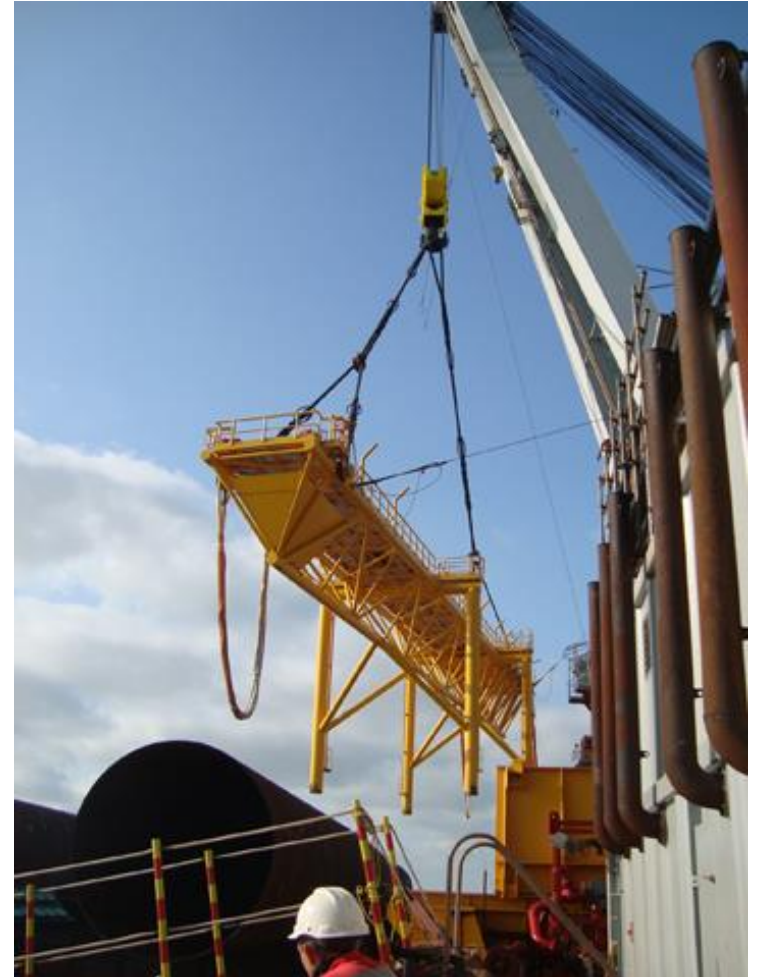
▪ Samson and distributors

- Sling brochure specifies use in accordance with ASME B30.9-4.2.4
- To cover the information gap further:
 - *Sling configurator*
 - *Technical sales*
 - *Application engineers*

Sling Standards



- **Samson's sling brochure provides information about:**
 - **Standard hitch setups**
 - *Single leg and grommet*
 - *Vertical and basket choker*
 - **D/d ration ratings**
 - *D: pin or object diameter*
 - *d: rope diameter*
 - *Rated capacity: basket rating x efficiency*
 - **Other relevant information**
 - *Chemical resistance*
 - *Temperature*
 - *UV resistance*



Sling Standards: Basket Lift Example



- **AmSteel®-Blue eye-and-eye sling**
 - 1" diameter
 - 98,000 lb. MBS
- **Lift**
 - **Basket configuration**
 - 12" object diameter
 - 5:1 safety factor
- **Rated capacity**
 - **Vertical**
 - $98,000 / 5 = 19,600 \text{ lb.}$
 - **Basket D/d = 25:1**
 - $19,600 \times 2 = 39,200 \text{ lb.}$
 - **Reduction for D/d = 12:1**
 - *Reduction factor of 0.85*
 - $39,200 \times 0.85 = 33,300 \text{ lb.}$

Formula for calculating rated capacity (single-leg slings)

D/d	20	10	5	2	1
Retained Strength	95%	85%	75%	60%	50%

Sling Considerations: Sling MBL vs. WLL

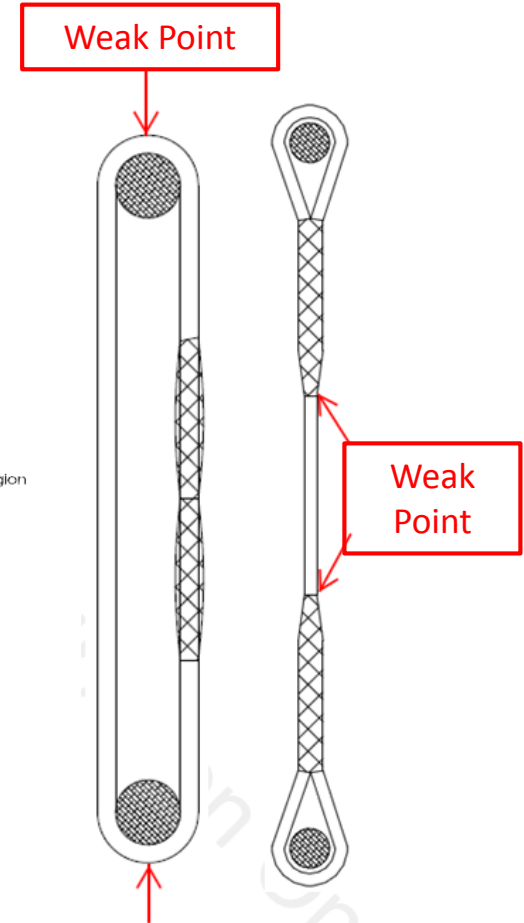
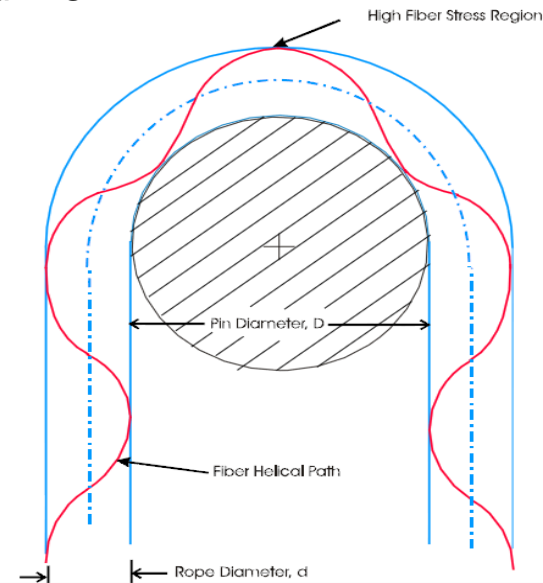


- **Customer supplies**
 - **MBL: required breaking strength**
 - *Working load required x safety factor*
 - **Bend diameter of connecting hardware**
 - **Fit on rigging: min/max diameter requirement (to fit on hardware)**
 - **Length: min/max effective length**
- **Manufacturer supplies**
 - **Ideal sling configuration (grommet or single leg)**
 - **Length and fit confirmation**
 - **Breaking strength**
 - *Accounting for necessary de-ratings (bend, etc.)*

Sling Considerations: Single-Leg vs. Grommet Slings



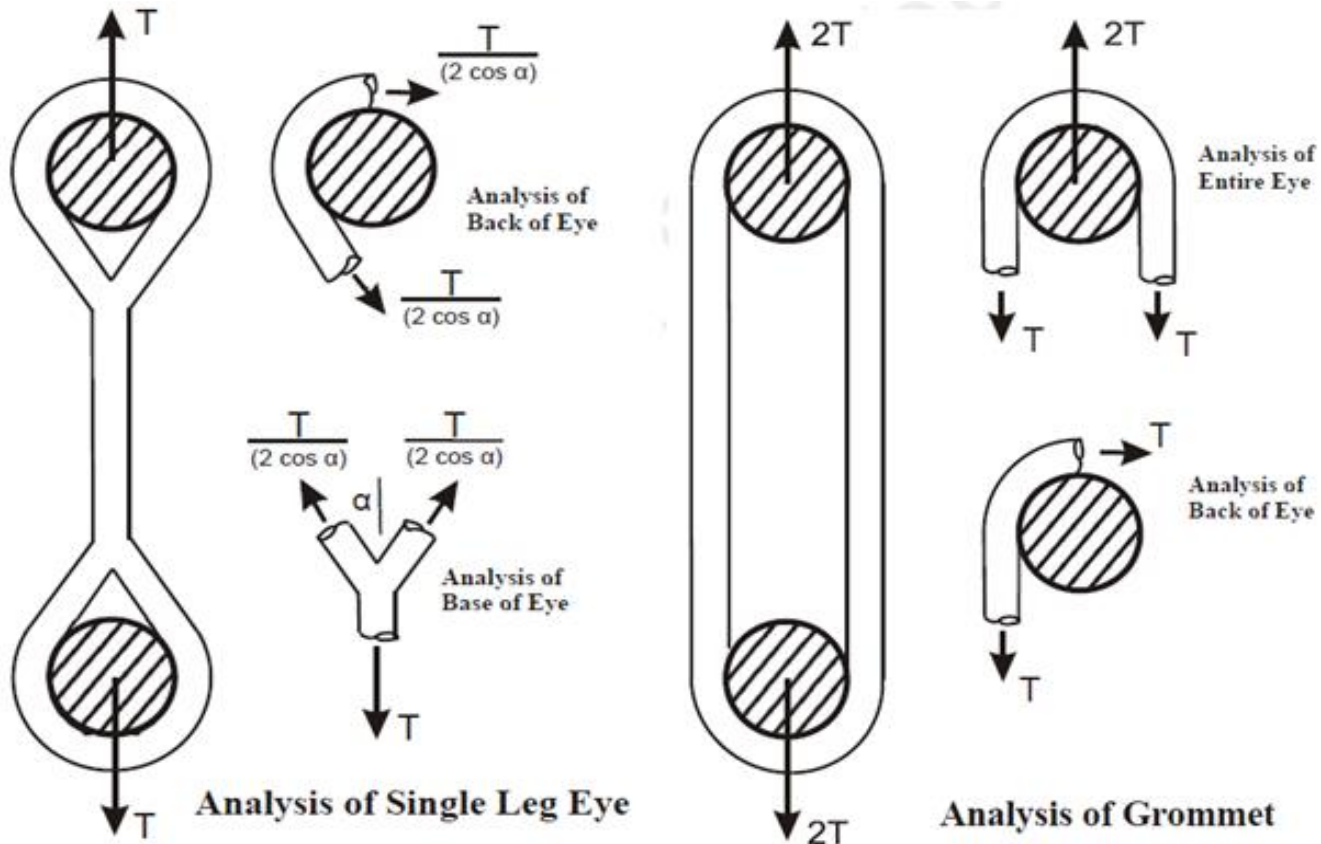
- **Impact of bend**
 - **Sling leg**
 - *Minimum $D/d = 1:1$*
 - *No strength impact for any $D/d > 1:1$*
 - **Grommet**
 - *Recommended minimum $D/d = 3:1$*
 - *Minimum $D/d = 1:1$*
 - *Strength de-rating for $D/d < 8:1$*



Sling Considerations: Single-Leg vs. Grommet Slings



- Schematic of failure zone comparison



Sling Considerations: Single-Leg vs. Grommet Slings

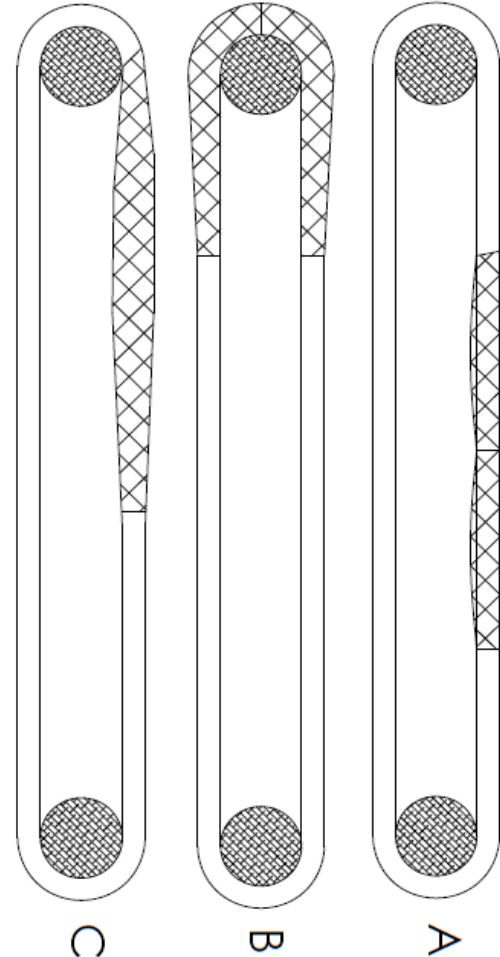


- **Single-leg slings**
 - **Pros**
 - *Efficient use of fiber*
 - *Less impact of small bend diameter*
 - **Cons**
 - *Larger diameter (fit on hardware)*
 - *Longer minimum length requirement*
- **Grommet slings**
 - **Pros**
 - *Can build shorter lengths*
 - *Small diameter fit on hardware*
 - **Cons**
 - *Usually higher price (per ton MBL)*
 - *Less efficient use of fiber*

Sling Considerations



- **Grommet splice location**
 - **Recommended splice locations**
 - *Centered on one leg (A)*
 - *Centered on one bearing point (B)*
 - **Not recommended**
 - *Splice tail “pinched” on bearing point*
- **Options A and B offer full strength efficiency**
- **Option B will create large “effective diameter”**
- **Option C can create unpredictable results**



Sling Considerations



- **Protection – jacketed vs. single braid**
- **Single braid (non-jacketed)**
 - **Pros**
 - *Easy inspection*
 - *Flexibility*
 - *Efficient (\$/ton)*
 - *Proven*
 - **Cons**
 - *May require cover*
 - *Too flexible?*
- **Jacketed**
 - **Pros**
 - *Abrasion protection*
 - **Cons**
 - *Stiff (difficult to handle)*
 - *Cannot inspect*
 - *\$/ton*

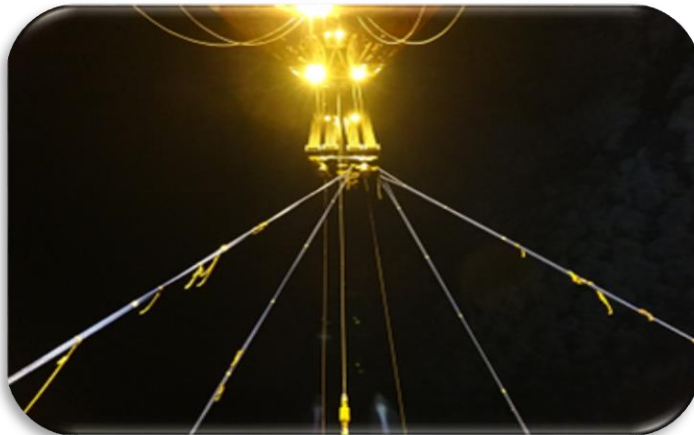


Heavy Lift Project



▪ CNOOC/COOEC

- Project: jacketed heavy lift
- Location: South China Sea
- Product: AmSteel®-Blue (178mm)
- Details
 - *Jacketed heavy lift*
 - *MBL: 2,850t (basket)*
 - *Certification: ABS*
 - *Weight reduction needed to suit crane capacity*

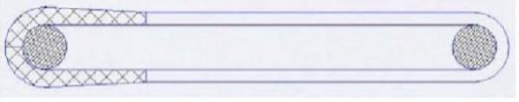
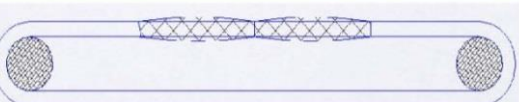

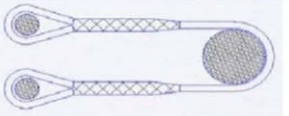


Sling Configurator



INPUTS	
Units:	Metric (mm)
Product:	Amsteel Blue
Overall Length	12,000 mm
Pin Diameters	
Pin (Left)	150.00 mm
Pin (Right)	150.00 mm
Minimum Eye (Left) =	450 mm
Minimum Eye (Right) =	450 mm
Eye Size (Left)	450 mm
Eye Size (Right)	450 mm
Load Requirements (Enter 2 of 3)	
Breaking Strength	1,500 MT
WLL	300 MT
FoS	
Proof Load Requirements	
Proof Load	600 MT
Standard/Guidelines	
Length Tolerance	
Absolute OAL	%
Matched Slings OAL	%
Rope Diameter Requirement	
Max Rope Diameter	mm
Splice Method	Tuck-Bury



Grommet - Splice Centered on pin			
	Rope Diameter	112 mm	4.625 in
	ISO MBS	1,599.78	MT
	SRT MBS	3,173,779	lbs
Minimum Length		4.722	m
		15.491	ft
Min Tolerance, %			
Grommet - Splice Centered on (1) Leg			
	Rope Diameter	112 mm	4.625 in
	ISO MBS	1,599.78	MT
	SRT MBS	3,173,779	lbs
Minimum Length		9.218	m
		30.245	ft
Min Tolerance, %			
Single Leg - Straight Pull			
	Rope Diameter	140 mm	5.750 in
	ISO MBS	1,562.00	MT
	SRT MBS	3,099,000	lbs
Minimum Length (Eyes = 3x Pin Dia)		12.536	m
		41.129	ft
Min Tolerance, %			
Single Leg - Basket Lift			
	Rope Diameter	112 mm	4.625 in
	ISO MBS	1,599.78	MT
	SRT MBS	3,173,779	lbs
Minimum Length (Eyes = 3x Pin Dia)		6.578	m
		21.584	ft
Min Tolerance, %			

Key Documents



- **Technical bulletins**
 - Industrial Rope Selection, Usage, and Retirement
 - Inspection and Retirement Pocket Guide
- **Inspection and Retirement Pocket Guide**
 - Field-use pocket guide
 - Field-use iPhone app





For additional information, please visit
www.SamsonRope.com