Technical Literature

# Toro® Sling Ratings

CORTLAND INTERNATIONAL™

# Guidance for safe use

## The purpose of this document is to provide technical sling performance data for safe choice and use of Cortland International's Toro® high performance synthetic slings.

While Cortland does manufacture heavy lift slings from other modern synthetic fiber materials such as Technora® (Aramid), Vectran® (LCP), Polyester and Nylon (Polyamide), the most popular fiber is Ultra High Molecular Weight Polyethylene (UHMWPE). Toro® UHMWPE rope slings are extremely durable, have superior strength/weight benefits and have elongation properties after proof loading, similar to wire rope. Specifications of a synthetic rope sling may include additional mechanical components such as end termination hardware, (e.g. thimbles), fittings, (e.g. shackles) and wear protection. These slings are excellent lightweight lifting tools and can be used for many land-based and marine lifting applications.

If the information provided within this document does not address or answer all product support needs, please contact Cortland International at contact@cortlandinternational.com.

**Toro®–Proven Strength and Durability**
Toro® from Cortland is a rope solution manufactured from Ultra High Molecular Weight Polyethylene (UHMWPE) fiber. This incredibly durable 12-strand or 12x12 braided rope features superior flex fatigue and wear resistance properties.

With an unsurpassed strength-to-weight ratio, it matches the strength of steel wire rope at the same size making it an exceptional lightweight replacement option. Engineered with a pliable, torque-free braided design, Toro rope is an easy-to-handle and economic solution.

**Toro 12-Strand**
Toro 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 Toro rope is very durable, cut resistant (compared to other synthetic ropes) and has very good UV resistance. It also has excellent bending flex fatigue—far superior to wire rope. It is extremely flexible and conforms easily to surfaces.

**Toro 12x12**
Toro 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. Toro 12x12 is supplied with our standard polyurethane finish, although other coatings can be applied to suit specific applications.

## Toro® Sling Ratings in Hitch Configuration—LBS

### Eye & Eye Sling

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 | Vertical | Choker (120° or >) | 90° | 60° | 45° | 30° |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Sling Capacity Ratings at Work Load Limits (WLL) in Pounds | | | | | |
| Dia. inch | Dia. mm | Circ. inch | MBL- Pounds | | Toro® 12-Strand | | | | | |
| 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 | 22,000 | 3' 0" | 4,400 | 3,080 | 8,800 | 7,620 | 6,220 | 4,400 |
| 1/2 | 12 | 1-1/2 | 30,500 | 3' 2" | 6,100 | 4,270 | 12,200 | 10,500 | 8,620 | 6,100 |
| 9/16 | 14 | 1-3/4 | 36,500 | 3' 6" | 7,300 | 5,110 | 14,600 | 12,600 | 10,300 | 7,300 |
| 5/8 | 16 | 2 | 47,800 | 3' 10" | 9,500 | 6,690 | 19,000 | 16,500 | 13,500 | 9,500 |
| 3/4 | 18 | 2-1/4 | 61,800 | 4' 4" | 12,300 | 8,650 | 24,600 | 21,400 | 17,400 | 12,300 |
| 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 | 84,300 | 4' 11" | 16,800 | 11,800 | 33,600 | 29,200 | 23,800 | 16,800 |
| 1 | 24 | 3 | 105,000 | 5' 5" | 21,000 | 14,700 | 42,000 | 36,300 | 29,600 | 21,000 |
| 1-1/16 | 26 | 3-1/4 | 121,600 | 5' 8" | 24,300 | 17,000 | 48,600 | 42,100 | 34,300 | 24,300 |
| 1-1/8 | 28 | 3-1/2 | 137,000 | 5' 11" | 27,400 | 19,100 | 54,800 | 47,400 | 38,700 | 27,400 |
| 1-1/4 | 30 | 3-3/4 | 157,000 | 6' 6" | 31,400 | 21,900 | 62,800 | 54,300 | 44,400 | 31,400 |
| 1-5/16 | 32 | 4 | 176,400 | 6' 10" | 35,200 | 24,600 | 70,400 | 61,100 | 49,800 | 35,200 |
| 1-1/2 | 36 | 4-1/2 | 215,000 | 7' 7" | 43,000 | 30,100 | 86,000 | 74,400 | 60,800 | 43,000 |
| | | | | | Toro® 12x12 | | | | | |
| 1-5/8 | 40 | 5 | 245,000 | 9' 1" | 49,000 | 34,300 | 98,000 | 84,800 | 69,200 | 49,000 |
| 1-3/4 | 44 | 5-1/2 | 284,300 | 9' 10" | 56,800 | 39,800 | 113,600 | 98,400 | 80,400 | 56,800 |
| 2 | 48 | 6 | 369,900 | 11' 0" | 73,900 | 51,700 | 147,800 | 128,100 | 104,600 | 73,900 |
| 2-1/8 | 52 | 6-1/2 | 423,900 | 11' 7" | 84,700 | 59,300 | 169,400 | 146,800 | 119,800 | 84,700 |
| 2-1/4 | 56 | 7 | 470,100 | 12' 4" | 94,000 | 65,800 | 188,000 | 162,800 | 132,900 | 94,000 |
| 2-1/2 | 60 | 7-1/2 | 569,400 | 13' 6" | 113,800 | 79,700 | 227,600 | 197,200 | 161,000 | 113,800 |
| 2-5/8 | 64 | 8 | 630,300 | 14' 1" | 126,000 | 88,200 | 252,000 | 218,300 | 178,200 | 126,000 |
| 2-3/4 | 68 | 8-1/2 | 698,400 | 14' 8" | 139,600 | 97,700 | 279,200 | 241,900 | 197,500 | 139,600 |
| 3 | 72 | 9 | 819,000 | 16' 0" | 163,800 | 114,600 | 327,600 | 283,700 | 231,600 | 163,800 |
| 3-1/8 | 76 | 9-1/2 | 886,500 | 16' 7" | 177,300 | 124,100 | 354,600 | 307,000 | 250,700 | 177,300 |
| 3-1/4 | 80 | 10 | 961,300 | 17' 2" | 192,200 | 134,500 | 384,400 | 333,000 | 271,800 | 192,200 |
| 3-1/2 | 84 | 10-1/2 | 1,095,300 | 18' 6" | 219,000 | 153,300 | 438,000 | 379,400 | 309,700 | 219,000 |
| 3-5/8 | 88 | 11 | 1,184,300 | 19' 1" | 236,800 | 165,800 | 473,600 | 410,200 | 334,900 | 236,800 |
| 3-3/4 | 92 | 11-1/2 | 1,273,100 | 19' 8" | 254,600 | 178,200 | 509,200 | 441,000 | 360,000 | 254,600 |
| 4 | 96 | 12 | 1,435,200 | 21' 0" | 287,000 | 200,900 | 574,000 | 497,000 | 405,900 | 287,000 |
| 4-1/8 | 100 | 12-1/2 | 1,523,400 | 21' 7" | 304,600 | 213,200 | 609,200 | 527,000 | 430,800 | 304,600 |
| 4-1/4 | 104 | 13 | 1,618,600 | 22' 2" | 323,700 | 226,600 | 647,400 | 560,000 | 457,800 | 323,700 |

Minimum Break Load (MBL) in pounds or tonnes and is determined using spliced test samples in accordance with Cordage Institute 1500-02 - Test Method for Fiber Ropes.
Minimum Sling Length on Eye & Eye fabricated Cortland slings assumes 1) a *compressed* minimum eye splice 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 lifting sling standards including ASME B30.9. This design factor takes into account various factors including the use of UHMWPE (Ultra High Molecular Weight Polyethylene) fiber which is extremely durable and resistant to repeated high loads. Toro® rope slings have and can be used with different DF ratios: however, this is a decision which must be made by a qualified person or designer of the lift in conjunction with the rope manufacturer.
Cortland, at this time, does not recommend the use of Toro rope slings in a choker hitch at a lifting angle of less than 120°. Testing on rated values is not complete and available at this time.

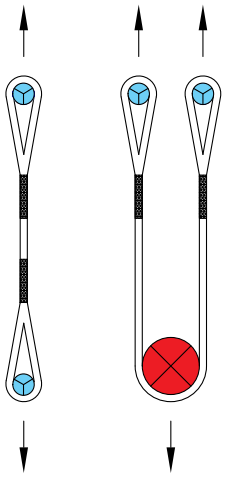
## Toro® Sling Ratings in Hitch Configuration—LBS

**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, because of bending reductions this theory is incorrect. Users must reduce that factor-of-two by an efficiency factor (i.e., a bending reduction factor).

The more tight a bend is, the more the bending efficiency reduces. If you have a gentle bend, the D:d ratio might be very high. But as the D:d ratio goes down, the bending reduction increases. Example: a 5:1 D:d ratio provides only 80% efficiency.

| Reduced Basket Capacity Calculation |
|---|
| **C = B x 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% |

## Toro® Sling Ratings in Hitch Configuration—LBS

### Endless Grommet Slings

One splice in one leg
Vertical, choker and basket hitches
Basket hitch at varying angles

| Nominal Size | | | | Minimum Sling Length Ft/Inch | Sling Capacity Ratings at Work Load Limits (WLL) in Pounds | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Vertical | Choker (120° or >) | 90° | 60° | 45° | 30° |
| Dia. inch | Dia. mm | Circ. inch | MBL- Pounds | | Toro® 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 | 19,300 | 0' 8" | 3,860 | 1,630 | 6,940 | 6,010 | 4,910 | 3,470 |
| 3/8 | 9 | 1-1/8 | 28,800 | 0' 10" | 5,760 | 2,440 | 10,300 | 8,970 | 7,330 | 5,180 |
| 7/16 | 11 | 1-1/4 | 36,300 | 0' 11" | 7,260 | 3,080 | 13,000 | 11,300 | 9,240 | 6,530 |
| 1/2 | 12 | 1-1/2 | 50,300 | 1' 0" | 10,000 | 4,260 | 18,100 | 15,600 | 12,800 | 9,050 |
| 9/16 | 14 | 1-3/4 | 60,200 | 1' 2" | 12,000 | 5,100 | 21,600 | 18,700 | 15,300 | 10,800 |
| 5/8 | 16 | 2 | 78,800 | 1' 4" | 15,700 | 6,680 | 28,300 | 24,500 | 20,000 | 14,100 |
| 3/4 | 18 | 2-1/4 | 101,900 | 1' 6" | 20,300 | 8,640 | 36,600 | 31,700 | 25,900 | 18,300 |
| 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 | 139,000 | 1' 10" | 27,800 | 11,700 | 50,000 | 43,300 | 35,300 | 25,000 |
| 1 | 24 | 3 | 173,200 | 2' 0" | 34,600 | 14,600 | 62,300 | 53,900 | 44,000 | 31,100 |
| 1-1/16 | 26 | 3-1/4 | 200,600 | 2' 2" | 40,100 | 17,000 | 72,200 | 62,500 | 51,000 | 36,100 |
| 1-1/8 | 28 | 3-1/2 | 226,000 | 2' 4" | 45,200 | 19,100 | 81,300 | 70,400 | 57,500 | 40,600 |
| 1-1/4 | 30 | 3-3/4 | 259,000 | 2' 6" | 51,800 | 21,900 | 93,200 | 80,700 | 65,900 | 46,600 |
| 1-5/16 | 32 | 4 | 291,000 | 2' 8" | 58,200 | 24,600 | 104,700 | 90,700 | 74,000 | 52,300 |
| 1-1/2 | 36 | 4-1/2 | 354,700 | 3' 0" | 70,900 | 30,000 | 127,600 | 110,500 | 90,200 | 63,800 |
| | | | | | Toro® 12x12 | | | | | |
| 1-5/8 | 40 | 5 | 404,200 | 3' 4" | 80,800 | 34,200 | 145,500 | 126,000 | 102,800 | 72,700 |
| 1-3/4 | 44 | 5-1/2 | 469,000 | 3' 6" | 93,800 | 39,700 | 168,800 | 146,200 | 119,300 | 84,400 |
| 2 | 48 | 6 | 610,300 | 4' 0" | 122,000 | 51,700 | 219,700 | 190,200 | 155,300 | 109,800 |
| 2-1/8 | 52 | 6-1/2 | 699,400 | 4' 4" | 139,800 | 59,300 | 251,700 | 218,000 | 178,000 | 125,800 |
| 2-1/4 | 56 | 7 | 775,600 | 4' 6" | 155,100 | 65,800 | 279,200 | 241,800 | 197,400 | 139,600 |
| 2-1/2 | 60 | 7-1/2 | 939,500 | 5' 0" | 187,900 | 79,700 | 338,200 | 292,900 | 239,100 | 169,100 |
| 2-5/8 | 64 | 8 | 1,039,900 | 5' 4" | 207,900 | 88,200 | 374,300 | 324,200 | 264,700 | 187,100 |
| 2-3/4 | 68 | 8-1/2 | 1,152,300 | 5' 6" | 230,400 | 97,700 | 414,800 | 359,200 | 293,300 | 207,400 |
| 3 | 72 | 9 | 1,351,300 | 6' 0" | 270,200 | 114,600 | 486,400 | 421,200 | 343,900 | 243,200 |
| 3-1/8 | 76 | 9-1/2 | 1,462,700 | 6' 4" | 292,500 | 124,100 | 526,000 | 456,000 | 372,300 | 263,200 |
| 3-1/4 | 80 | 10 | 1,586,100 | 6' 6" | 317,200 | 134,500 | 570,000 | 494,400 | 403,700 | 285,400 |
| 3-1/2 | 84 | 10-1/2 | 1,807,200 | 7' 0" | 361,400 | 153,300 | 650,000 | 563,000 | 460,000 | 325,200 |
| 3-5/8 | 88 | 11 | 1,954,000 | 7' 4" | 390,800 | 165,700 | 703,000 | 609,000 | 497,000 | 351,700 |
| 3-3/4 | 92 | 11-1/2 | 2,100,600 | 7' 6" | 420,100 | 178,200 | 756,000 | 654,000 | 534,000 | 378,100 |
| 4 | 96 | 12 | 2,368,000 | 8' 0" | 473,000 | 200,900 | 852,000 | 738,000 | 602,000 | 426,200 |
| 4-1/8 | 100 | 12-1/2 | 2,513,600 | 8' 4" | 502,000 | 213,200 | 904,000 | 783,000 | 639,000 | 452,400 |
| 4-1/4 | 104 | 13 | 2,670,600 | 8' 6" | 534,000 | 226,500 | 961,000 | 832,000 | 679,000 | 480,000 |

Minimum Break Load (MBL) in pounds or tonnes and is determined using spliced test samples in accordance with Cordage Institute 1500-02 - Test Method for Fiber Ropes.
Specifications for endless loop (grommet) Toro® 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 lifting sling standards including ASME B30.9. This design factor takes into account various factors including the use of UHMWPE (Ultra High Molecular Weight Polyethylene) fiber which is extremely durable and resistant to repeated high loads. Toro® rope slings have and can be used with different DF ratios: however, this is a decision which must be made by a qualified person or designer of the lift in conjunction with the rope manufacturer.
Cortland, at this time, does not recommend the use of Toro rope slings in a choker hitch at a lifting angle of less than 120°. Testing on rated values is not complete and available at this time.

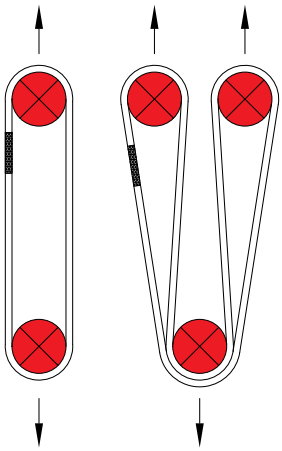
 

## Toro® Sling Ratings in Hitch Configuration—LBS

**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, because of bending reductions this theory is incorrect. Users must reduce that factor-of-two by an efficiency factor (i.e., a bending reduction factor).

The more tight a bend is, the more the bending efficiency reduces. If you have a gentle bend, the D:d ratio might be very high. But as the D:d ratio goes down, the bending reduction increases. Example: a 5:1 D:d ratio provides only 97% efficiency.

| Reduced Basket Capacity Calculation |
|---|
| **C = B x 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% |

## Toro® Sling Ratings in Hitch Configuration—MT (tonnes)

### Eye & Eye Sling

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 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Vertical | Choker (120° or >) | 90° | 60° | 45° | 30° |
| Dia. inch | Dia. mm | Circ. inch | MBL tonnes | | Toro® 12-Strand | | | | | |
| 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 | 10.0 | 0.9 | 1.9 | 1.3 | 3.9 | 3.4 | 2.8 | 1.9 |
| 1/2 | **12** | 1-1/2 | 13.8 | 1.0 | 2.7 | 1.9 | 5.5 | 4.7 | 3.9 | 2.7 |
| 9/16 | **14** | 1-3/4 | 16.6 | 1.1 | 3.3 | 2.3 | 6.6 | 5.7 | 4.6 | 3.3 |
| 5/8 | **16** | 2 | 21.7 | 1.2 | 4.3 | 3.0 | 8.6 | 7.5 | 6.1 | 4.3 |
| 3/4 | **18** | 2-1/4 | 28.0 | 1.3 | 5.6 | 3.9 | 11.2 | 9.7 | 7.9 | 5.6 |
| 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 | 38.2 | 1.5 | 7.6 | 5.3 | 15.2 | 13.2 | 10.8 | 7.6 |
| 1 | **24** | 3 | 47.6 | 1.7 | 9.5 | 6.6 | 19.0 | 16.4 | 13.4 | 9.5 |
| 1-1/16 | **26** | 3-1/4 | 55.2 | 1.8 | 11.0 | 7.7 | 22.0 | 19.1 | 15.6 | 11.0 |
| 1-1/8 | **28** | 3-1/2 | 62.1 | 1.8 | 12.4 | 8.6 | 24.8 | 21.5 | 17.5 | 12.4 |
| 1-1/4 | **30** | 3-3/4 | 71.2 | 2.0 | 14.2 | 9.9 | 28.4 | 24.6 | 20.1 | 14.2 |
| 1-5/16 | **32** | 4 | 80.0 | 2.1 | 16.0 | 11.2 | 32.0 | 27.7 | 22.6 | 16.0 |
| 1-1/2 | **36** | 4-1/2 | 97.5 | 2.3 | 19.5 | 13.6 | 39.0 | 33.7 | 27.5 | 19.5 |
| | | | | | Toro® 12x12 | | | | | |
| 1-5/8 | **40** | 5 | 111 | 2.8 | 22 | 15 | 44 | 38 | 31 | 22 |
| 1-3/4 | **44** | 5-1/2 | 128 | 3.0 | 25 | 17 | 51 | 44 | 36 | 25 |
| 2 | **48** | 6 | 167 | 3.4 | 33 | 23 | 66 | 57 | 47 | 33 |
| 2-1/8 | **52** | 6-1/2 | 192 | 3.6 | 38 | 26 | 76 | 66 | 54 | 38 |
| 2-1/4 | **56** | 7 | 213 | 3.8 | 42 | 29 | 85 | 73 | 60 | 42 |
| 2-1/2 | **60** | 7-1/2 | 258 | 4.1 | 51 | 36 | 103 | 89 | 72 | 51 |
| 2-5/8 | **64** | 8 | 285 | 4.3 | 57 | 39 | 114 | 98 | 80 | 57 |
| 2-3/4 | **68** | 8-1/2 | 316 | 4.5 | 63 | 44 | 126 | 109 | 89 | 63 |
| 3 | **72** | 9 | 371 | 4.9 | 74 | 51 | 148 | 128 | 104 | 74 |
| 3-1/8 | **76** | 9-1/2 | 402 | 5.1 | 80 | 56 | 160 | 139 | 113 | 80 |
| 3-1/4 | **80** | 10 | 436 | 5.3 | 87 | 61 | 174 | 151 | 123 | 87 |
| 3-1/2 | **84** | 10-1/2 | 496 | 5.7 | 99 | 69 | 198 | 171 | 140 | 99 |
| 3-5/8 | **88** | 11 | 537 | 5.9 | 107 | 75 | 214 | 186 | 151 | 107 |
| 3-3/4 | **92** | 11-1/2 | 577 | 6.0 | 115 | 80 | 230 | 199 | 163 | 115 |
| 4 | **96** | 12 | 650 | 6.4 | 130 | 91 | 260 | 225 | 183 | 130 |
| 4-1/8 | **100** | 12-1/2 | 691 | 6.6 | 138 | 96 | 276 | 239 | 195 | 138 |
| 4-1/4 | **104** | 13 | 734 | 6.8 | 146 | 102 | 293 | 254 | 207 | 146 |

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Minimum Sling Length on Eye & Eye fabricated Cortland slings assumes 1) a *compressed* minimum eye splice 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.
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| Reduced Basket Capacity Calculation |
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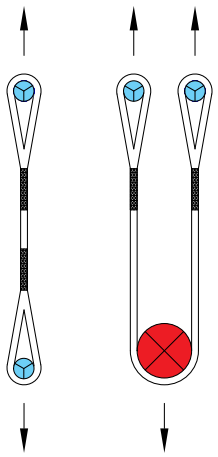
| e = Bending efficiency percentage |



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### Endless Grommet Slings

One splice in one leg
Vertical, choker and basket hitches
Basket hitch at varying angles

| Nominal Size | | | | Minimum Sling Length m | Sling Capacity Ratings at Work Load Limits (WLL) in tonnes | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Vertical | Choker (120° or >) | 90° | 60° | 45° | 30° |
| Dia. inch | Dia. mm | Circ. inch | MBL tonnes | | Toro® 12-Strand | | | | | |
| 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 | 16.4 | 0.3 | 3.2 | 1.3 | 5.9 | 5.1 | 4.1 | 2.9 |
| 1/2 | **12** | 1-1/2 | 22.8 | 0.4 | 4.5 | 1.9 | 8.2 | 7.1 | 5.8 | 4.1 |
| 9/16 | **14** | 1-3/4 | 27.3 | 0.4 | 5.4 | 2.3 | 9.8 | 8.5 | 6.9 | 4.9 |
| 5/8 | **16** | 2 | 35.7 | 0.4 | 7.1 | 3.0 | 12.8 | 11.1 | 9.0 | 6.4 |
| 3/4 | **18** | 2-1/4 | 46.2 | 0.5 | 9.2 | 3.9 | 16.6 | 14.4 | 11.7 | 8.3 |
| 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 | 63.0 | 0.6 | 12.6 | 5.3 | 22.6 | 19.6 | 16.0 | 11.3 |
| 1 | **24** | 3 | 78.5 | 0.7 | 15.7 | 6.6 | 28.2 | 24.4 | 19.9 | 14.1 |
| 1-1/16 | **26** | 3-1/4 | 90.9 | 0.7 | 18.1 | 7.7 | 32.7 | 28.3 | 23.1 | 16.3 |
| 1-1/8 | **28** | 3-1/2 | 102.5 | 0.7 | 20.5 | 8.6 | 36.9 | 31.9 | 26.0 | 18.4 |
| 1-1/4 | **30** | 3-3/4 | 117.4 | 0.8 | 23.4 | 9.9 | 42.2 | 36.6 | 29.9 | 21.1 |
| 1-1/3 | **32** | 4 | 131.9 | 0.9 | 26.3 | 11.1 | 47.5 | 41.1 | 33.6 | 23.7 |
| 1-1/2 | **36** | 4-1/2 | 160.8 | 1.0 | 32.1 | 13.6 | 57.9 | 50.1 | 40.9 | 28.9 |
| | | | | | Toro® 12x12 | | | | | |
| 1-5/8 | **40** | 5 | 183 | 1.0 | 36 | 15 | 66 | 57 | 46 | 33 |
| 1-3/4 | **44** | 5-1/2 | 212 | 1.1 | 42 | 18 | 76 | 66 | 54 | 38 |
| 2 | **48** | 6 | 276 | 1.3 | 55 | 23 | 99 | 86 | 70 | 49 |
| 2-1/8 | **52** | 6-1/2 | 317 | 1.3 | 63 | 26 | 114 | 98 | 80 | 57 |
| 2-1/4 | **56** | 7 | 351 | 1.4 | 70 | 29 | 126 | 109 | 89 | 63 |
| 2-1/2 | **60** | 7-1/2 | 426 | 1.6 | 85 | 36 | 153 | 132 | 108 | 76 |
| 2-5/8 | **64** | 8 | 471 | 1.7 | 94 | 40 | 169 | 147 | 120 | 84 |
| 2-3/4 | **68** | 8-1/2 | 522 | 1.7 | 104 | 44 | 188 | 162 | 133 | 94 |
| 3 | **72** | 9 | 612 | 1.9 | 122 | 52 | 220 | 191 | 156 | 110 |
| 3-1/8 | **76** | 9-1/2 | 663 | 2.0 | 132 | 56 | 238 | 206 | 168 | 119 |
| 3-1/4 | **80** | 10 | 719 | 2.0 | 143 | 61 | 258 | 224 | 183 | 129 |
| 3-1/2 | **84** | 10-1/2 | 819 | 2.2 | 163 | 69 | 295 | 255 | 208 | 147 |
| 3-5/8 | **88** | 11 | 886 | 2.3 | 177 | 75 | 319 | 276 | 225 | 159 |
| 3-3/4 | **92** | 11-1/2 | 952 | 2.3 | 190 | 80 | 343 | 297 | 242 | 171 |
| 4 | **96** | 12 | 1,074 | 2.5 | 214 | 91 | 386 | 334 | 273 | 193 |
| 4-1/8 | **100** | 12-1/2 | 1,140 | 2.6 | 228 | 96 | 410 | 355 | 290 | 205 |
| 4-1/4 | **104** | 13 | 1,211 | 2.6 | 242 | 102 | 436 | 377 | 308 | 218 |

Minimum Break Load (MBL) in pounds or tonnes and is determined using spliced test samples in accordance with Cordage Institute 1500-02 - Test Method for Fiber Ropes.
Specifications for endless loop (grommet) Toro® 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 lifting sling standards including ASME B30.9. This design factor takes into account various factors including the use of UHMWPE (Ultra High Molecular Weight Polyethylene) fiber which is extremely durable and resistant to repeated high loads. Toro rope slings have and can be used with different DF ratios: however, this is a decision which must be made by a qualified person or designer of the lift in conjunction with the rope manufacturer.
Cortland, at this time, does not recommend the use of Toro rope slings in a choker hitch at a lifting angle of less than 120°. Testing on rated values is not complete and available at this time.

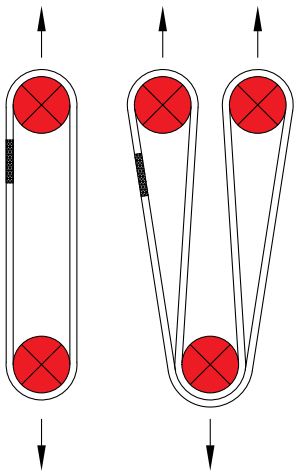
## Toro® Sling Ratings in Hitch Configuration—MT (tonnes)

**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, because of bending reductions this theory is incorrect. Users must reduce that factor-of-two by an efficiency factor (i.e., a bending reduction factor).

The more tight a bend is, the more the bending efficiency reduces. If you have a gentle bend, the D:d ratio might be very high. But as the D:d ratio goes down, the bending reduction increases. Example: a 5:1 D:d ratio provides only 97% efficiency.

| Reduced Basket Capacity Calculation |
|---|
| C = B x 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% |

## Notes

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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