EAGLE® XLD

Eagle XLD O-Rings:
Patented Bi-modulus Technology Providing Substantial Belt Life, Load, and Cost Improvement

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Introduction

Friction driven belts are widely used in various industrial and commercial applications, from HVAC systems to power transmission and roller conveyors. The selection of the appropriate belt for a specific application is crucial for ensuring optimal performance and longevity of the system.

The belt of choice for roller conveyor systems is often an O-Ring, a round belt section that is injection-molded or extruded and welded together without any reinforcement. The O-Ring is comprised of unreinforced polyurethane, and it can be installed by stretching it on two centers, without a tensioning system. The belt tension drives the rollers and transfers power from one roller to the next.

Using an unreinforced belt has two downsides. First, over time, the belt will “creep,” meaning it will permanently deform and lose tension, resulting in failure. Second, it lacks power transmission capability—because a belt transmits power by cyclically loading tension, when high tension is applied to an unreinforced belt, it tends to stretch out and will not transmit sufficient torque.

One solution to the downsides of an unreinforced belt is to reinforce belts with materials like Kevlar, Fiberglass, polyester, or polyamide. Unfortunately, a reinforced belt requires a tensioning system, such as an idler pulley, which adds cost and space to the system.

Background

Material handling equipment leverages chain-, direct-, and belt-driven systems for power transmission and motion control. Belt systems vary substantially from flat belt to modular plastic to roller conveyors. Material handling equipment has advanced while belt systems used in roller conveyors have primarily remained focused on two main friction drive designs—belt driven rollers and roller-to-roller systems.

Within roller-to-roller systems, where the belt is fixed between two rollers, O-Rings offer low load and low speed, with poly-v belts providing a high-load and high-speed option. Roller conveyor systems are increasingly advanced with faster speeds, zone-specific control, and higher output requirements.

The Challenge

O-Rings are elastic belts that are extruded or injection-molded and typically unreinforced. As a result, they have limited longevity, particularly as loads and line speeds increase. Belts will creep to a point where they slip and can no longer drive the subsequent roller. As loads increase or higher tension is applied, the belts show an increasing tendency to stretch.

While the elastic nature of the belt allows for installation without added tensioning, it limits transfer efficiency of the belt to 90% (by comparison, a poly-v system has a 98% transfer efficiency). As a result, O-Rings can support fewer rollers, requiring the conveyor to have more motors. Exact motor-to-roller ratios will vary based on system loads and speeds.

Poly-V belts have an increased load and life capability due to the use of the standard, elastic polyamide reinforcement. Belts will fail primarily due to flex fatigue within the reinforcement. As this occurs, the belt will stretch and lose tension, resulting in belt slippage.

Fenner Precision Polymers specializes in using polymers to provide value-adding solutions for power transmission and motion control. Following acquisition by Michelin in 2018, Fenner began collaborating with Michelin’s High Tech Materials Division R&D group to leverage its expansive knowledge of reinforcement in tires and beyond.

An ideal alternative is a reinforced O-Ring. While O-Rings can be reinforced, elastic reinforcements require a take up that would add cost and require more space within the system. If inelastic reinforcement is used, installation is unforgiving. This led the team to a proprietary bi-modulus reinforcement.

This reinforcement behaves like two separate reinforcements due to its dual-modulus construction. The lower, "stretchy" modulus provides elastic properties. The second, higher modulus leverages a more rigid nature once the material is stretched past the inflection point, at 3% elongation. The stress strain curve shown in Figure 1, illustrates this effect.

For a belting application, the lower modulus allows the belt to be installed easily, yet still apply a constant tension that "takes up" slack in the system. This functionality eliminates the need for an idler in the system, reducing overall cost.

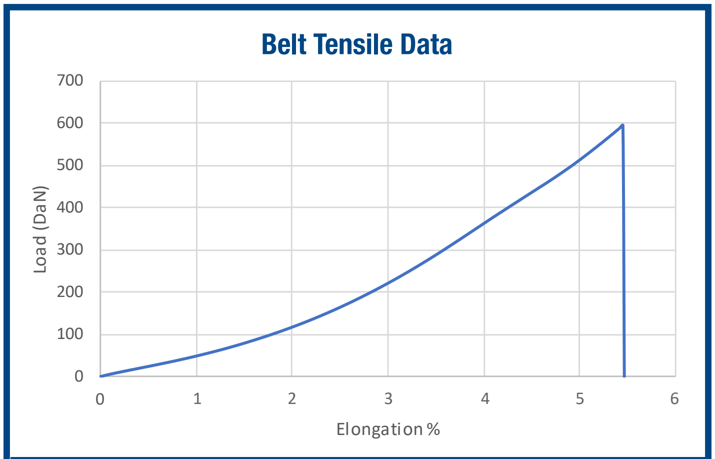


Figure 1: Bi-Modulus Stress Strain Curve

The higher modulus in a belting application reduces the creep or stretch over time, giving the belts longer life than an unreinforced or strictly low-modulus reinforcement. The second modulus also increases the power that the belt can transmit.

For these benefits to work in a belting application, the belt should be installed within 1% of the inflection point. For example, if the inflection point is at 3% elongation, the belt should be installed at 2% elongation. This allows both moduli to work in tandem, and to get the benefit of both a low- and high-modulus reinforcement.

Results:

Fenner's product development team modeled ideal ratios of belt length based on elongation to optimize the power transmission capability without sacrificing useful life or ease of install. The results establish the optimal belt length, given pulley diameters and center distance.

Tensile Decay Test

A 24-hour dynamometer test measures end load tension for a belt system, providing a visual indication of belt creep. Both standard O-Rings and the bi-modulus reinforced O-Rings were installed at the same tension and after 24 hours, the bi-modulus reinforced belt had less creep, as shown in Figure 2.

After 24 hours, the standard O-Ring belt decayed 42% more than the bi-modulus reinforced belt, exemplifying the mode of failure. After the test started, the bi-modulus belt had minimal creep, indicating that the belt will ultimately only fail due to flex fatigue, and not due to creep.

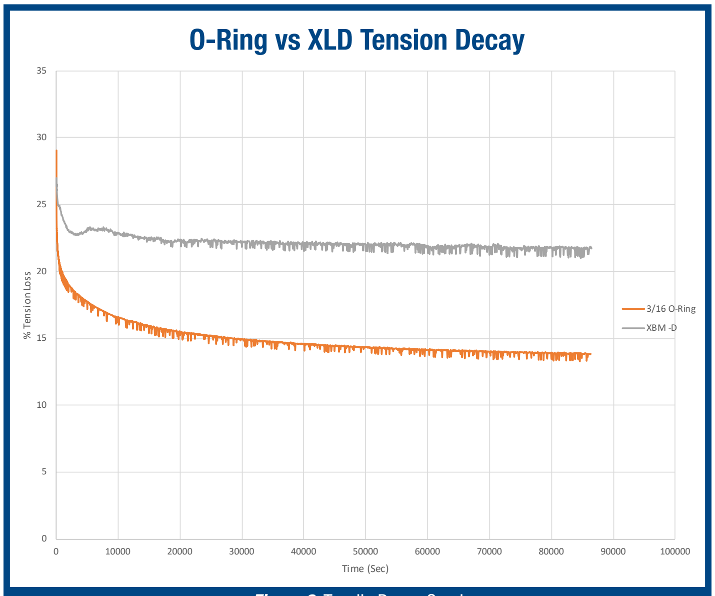
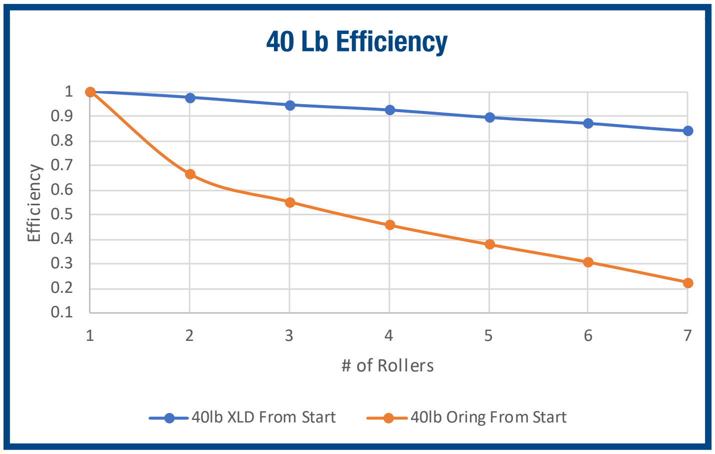


Figure 2: Tensile Decay Graph

Roller to Roller Transfer

Roller conveyors are commonly used in industrial and commercial settings to efficiently transport goods. One of the key advantages of using roller conveyors is their ability to increase torque transmission and reduce creep, which can improve overall conveyor efficiency. To better understand the performance of roller conveyors, Fenner conducted a series of tests on loaded roller-to-roller conveyors using O-Rings and XLD belts. The tests measured the RPM of the rollers from the driven roller to the subsequent rollers, loaded with 40 pounds of weight.

The results of the tests showed that while the O-Ring belt had an efficiency of around 90%, the XLD belt had an efficiency of close to 99% from roller to roller, **clearly demonstrating that the XLD belt can transfer more weight and can transmit power over more rollers per motor.**



Torque Ramp Test

The torque ramp test is a widely used method to evaluate the power transmission capabilities of a belt. During the test, standard and bi-modulus O-Rings are placed on a dynamometer and gradually increasing amounts of horsepower are applied. The standard belt is tensioned at 10% while the bi-modulus belt's tension is determined by the ideal belt length, optimized through a series of tests to ensure the best results in longevity and torque transmission.

As the horsepower increases, the belts naturally begin to slip at its maximum power transmission capacity, or 5%. The data presented in Figure 3 compare the power transmission capabilities of the different belt types, showing the variance in power transmission. This information can be used to improve the design and efficiency of belt-driven systems in various industrial and commercial applications.

The test indicates the XLD bi-modulus reinforced belt has six times more power transmission capability than a standard O-Ring.

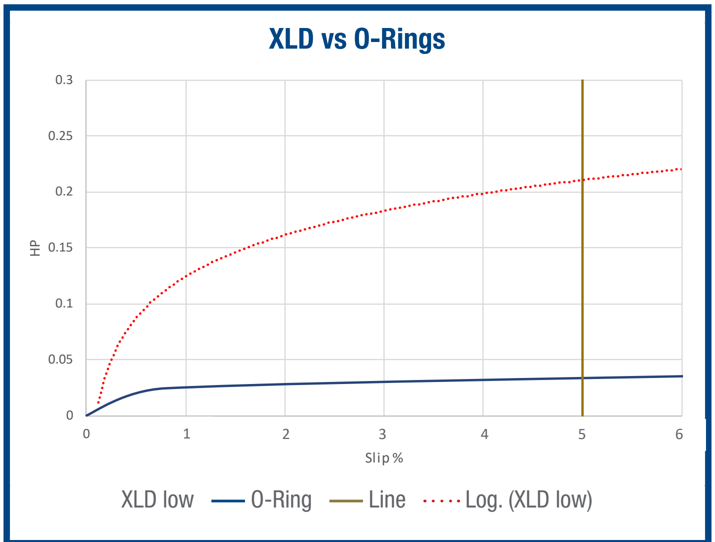


Figure 3: Torque Ramp Test

Conclusion

The bi-modulus reinforcement technology developed by the Fenner-Michelin team shows notable improvement in three key belt performance characteristics – belt creep, power transmission, and transfer efficiency.

To commercialize this capability, Fenner has added the reinforcement to the new Eagle XLD O-Ring, resulting in favorable improvements in belt life and power transmission. The reinforcement will provide:

- Six times the load carrying capability of a standard O-Ring
- Four times the life of a standard O-Ring
- Three times longer zones (from 5 rollers per motors in each direction, to 15)

For more information on bi-modulus reinforced belting, please reach out to our applications or sales team.
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