

# MINING & QUARRY WORLD



# When less is more



Single and dual-ply conveyor belts have been around for a very long time but up until fairly recently, they were only able to be used on low tensile strength, light applications. However, in recent years, new, technologically advanced versions have emerged that are breaking new ground. Thinner, lighter, yet much stronger, more resilient and longer lasting compared to their thicker, heavier, conventional multi-ply counterparts, they are fast becoming something of a phenomenon. The manufacturer behind this sea change, Fenner Dunlop Conveyor Belting, believe that single and dual-ply belts are the future. Conveyor specialist, Bob Nelson, explains how and why.

### A QUESTION OF STRENGTH

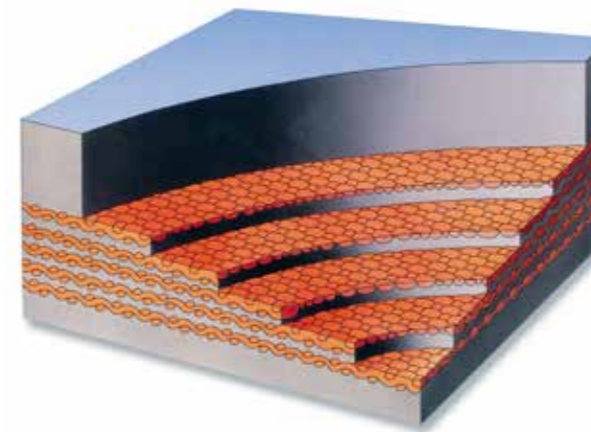
To understand how the 'new breed' single and dual-ply belts could possibly replace much thicker, multiple layer belts, it is important to bear in mind that the basic construction of rubber conveyor belts has not changed fundamentally since they were first invented in 1905. In those early days, belts were made from layered cotton and natural rubber. Since then, because of its vastly superior adaptability, the rubber is now almost totally synthetic, and the cotton fabric plies have long-since been replaced by stronger, more resilient, synthetic materials.

The multi-layered carcass structure usually consists of three or four layers of fabric with a thin 'skim' of rubber in between, protected by a much thicker outer layer of rubber. Belts for more extreme, heavy-duty applications can have as many as five or more layers but these are relatively unusual. Known the world over as 'multi-ply' belts, they are by far the most common type of conveyor belt.

Multi-ply belts are classified by two factors, the first being its longitudinal tensile strength. Measured in Newtons per millimetre (N/mm), it is commonly referred to as 'tensile strength at break', which means the maximum point of tension at which the belt will break into two parts. The second factor is the number of inner plies used. For example, a belt with a 400N/mm tensile strength constructed using three plies is referred to as a 400/3. Although well known by those involved with conveyor belts, what is perhaps not so well known is why multiple layers of fabric are needed to achieve a desired tensile strength and durability.

### WHY MULTIPLE PLYS?

The most commonly used fabric consists of a mixture of nylon and polyester (EP). This is because, for multi-ply belts, it traditionally has the best balance of mechanical properties. These include allowing the belt to run straight and true, to trough, to flex round pulleys and drums and stretch while at



Conventional multi-ply construction has not changed since 1905.

the same time providing sufficient transversal rigidity and longitudinal strength. Multiple plies are needed because there is a limit to the tensile strength of individual, conventionally designed fabrics. For example, a tensile strength of 400N/mm, is achieved by using the combined strength of multiple layers. A 'safety factor' needs to be included so in this example, the required 400 N/mm is usually achieved using three layers of 150N/mm strength fabric (3 X 150 = 450).

Another traditional reason for multiple layers is that belts need to be able to resist damage caused by the impact of heavy, often sharp objects, ripping and tearing. At the same time, they also need to provide adequate load support. Interestingly, another consideration is that the most commonly used method of joining two ends of a conveyor belt together is the 'step-splice', where layers are overlapped and joined using either cold glue or hot vulcanisation via a mobile press.

Unfortunately, it is not possible to make a splice joint in this way without losing the equivalent strength of at least one layer of fabric so this loss needs to be factored in when calculating the required tensile strength needed. For example, although the required tensile strength may only need to be 300N/mm, the 'loss' of one ply caused by the creation of the step-splice joint means that the combined strength of the remaining two plies needs to be at least 400N/mm. Likewise, a 630N/mm tensile strength has to be used even though the required tensile strength may only be 500N/mm, and so on.

### PLAY TO YOUR STRENGTHS – FOCUS ON YOUR COMPETITOR'S WEAKNESSES.

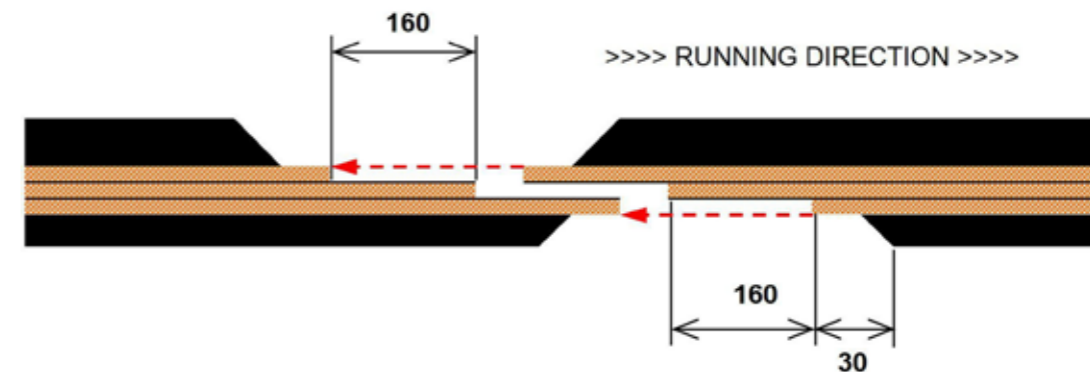
The conveyor belt market is fiercely competitive, with

imported 'economy' belt from Southeast Asia, primarily China, flooding the market, driving down quality standards and prices. As with so many other industries facing a similar dilemma, there are only two paths a manufacturer can choose from – compete on price or compete on quality. Even though history clearly shows that the 'low-price path' is downhill and littered with casualties, an increasing number of European conveyor belt manufacturers and traders are taking the 'cheap' imported belt route using the principle "If you cannot beat them, join them!"

At the quality end of the spectrum, the only choice open to premium-brand manufacturers such as Fenner Dunlop is 'innovate or suffocate'. A strategy stretching back more than 100 years based on innovation, product quality and longevity had always served them well. At the same time, to widen the differences in quality and 'lifetime cost', the company wanted to target what they saw as the three biggest weaknesses of the competition. Their aim, therefore, was to develop a new generation of belt that was not only considerably tougher but also more cost-effective and with a much lower environmental impact.



The 'low price path' is littered with casualties on both sides



A step splice joint loses the equivalent strength of at least one layer of fabric.

**THE USFLEX PHENOMENON**

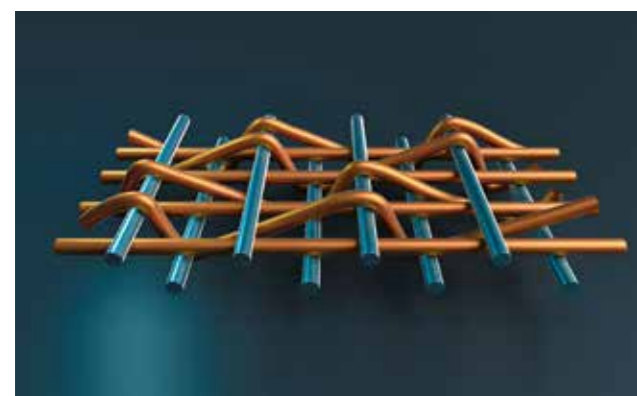
To achieve those objectives, Fenner Dunlop engineers in Europe and North America decided to build on a unique product that had already achieved an enviable reputation for toughness and longevity on both sides of the Atlantic – the single and dual-ply UsFlex construction. First introduced more than two decades ago, UsFlex combines premium grade rubber covers with uniquely designed super-strong fabric plies. Although available as a single-ply construction for lower tensile strength (up to 630Nmm) applications, the most popular version of UsFlex is the dual-ply 1000Nmm. The secret of its enormous success is its innovative, specially woven fabric consisting of heavy strands of polyester running lengthwise and heavy nylon strands running crosswise held in position by a strong yarn. The strands are completely straight in both directions and not interlocked like a conventional fabric. This allows the weft to float free from the warp, thereby dissipating impact energy over a larger area.

Even more importantly, the design also means that if a sharp object penetrates the carcass the nylon crosswise strands have the strength and 'freedom' to compact (gather) together in a bundle, effectively forming an increasingly stronger barrier that can eventually become strong enough to stop the belt or even expel the object causing the problem. Perhaps surprisingly, synthetic plies are usually more effective than steel when it comes to minimising the length of a rip.

The result is a carcass that possesses a longitudinal rip resistance that is more than five times greater than multi-ply belts of equivalent rating and up to three times greater impact resistance. Since its introduction, UsFlex has established a reputation for providing up to four or five times longer operational lifetime, especially when compared to belts imported from Southeast Asia. As one European quarry manager happily testified, "We used to replace our belts every three to six months before we started fitting UsFlex. Now it can be four or five years before we need to fit a replacement."

**ULTRA X – A SINGULAR SUCCESS**

Although conventional wisdom would seem to indicate that a higher number of inner plies will result in a stronger belt, this is most certainly not the case. The greatest influence on the strength and other essential physical properties of a conveyor belt is the design and quality of the ply material itself. UsFlex had already proved this to be true. The first challenge, however, was to invent a single fabric ply belt that would be a technically and commercially viable replacement for the most popular multi-ply applications – 400/3, 500/4 and 630/4. Fortunately, the big advantage



UsFlex belts have uniquely designed super-strong fabric plies that have amazing rip and impact resistance.

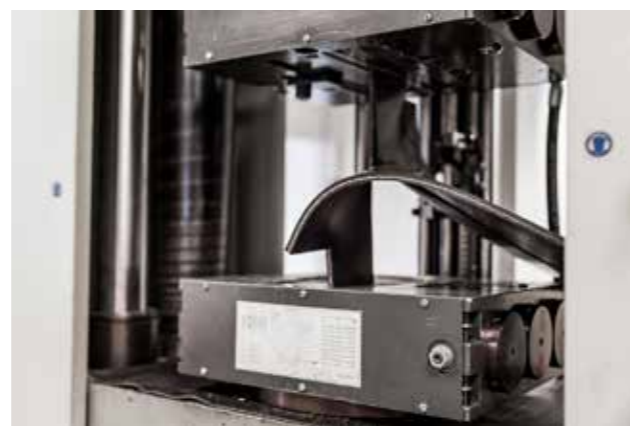


Tested to destruction – more than five times the longitudinal rip resistance and up to three times greater impact resistance compared to conventional belting

the Fenner Dunlop R&D teams had was an in-house fabric weaving facility where new fabric designs could be limitlessly explored. The result of their efforts was a super-strength single-ply belt that they named Ultra X.

Throughout its development, sections of belt carcass were repeatedly tested to destruction. The tests revealed that the new (Ultra X) fabric possessed more than **3 times** greater longitudinal rip resistance, up to **5 times** better tear resistance and a far superior resistance to impact compared to traditional 3-ply or even 4-ply belting. In short, Ultra X could withstand the kind of punishment that would destroy a normal belt. There was also no question about the overall strength. For example, the Ultra X3 single ply belt proved capable of pulling up to 56 tonnes in weight.

According to Dr. Michiel Eijpe, Fenner Dunlop's Innovation & Sustainability Director in the Netherlands, a key factor behind this amazing capability lies not only with the special fabric but also the advantages of finger splices.



EN ISO 505 tear resistance testing.

| No. of plies | Maximum % tensile strength |
|--------------|----------------------------|
| 1            | 90%                        |
| 2            | 50%                        |
| 3            | 67%                        |
| 4            | 75%                        |
| 5            | 80%                        |

Finger splice joints provide the greatest strength.



Home advantage - Fenner Dunlop's in-house fabric weaving facility in Lavonia, USA.

"Ultra X has amazing tensile strength. The longitudinal tensile strength of the X1 is 330N/mm and the X3 has a longitudinal strength of 550N/mm. Single-ply belts require a finger-splice joint, which retains up to 90% of the belt's tensile strength compared to a maximum of 67% for a 3-ply step joint".

The higher level of splice efficiency combined with the tensile strength effectively meant that Ultra X could safely be used to achieve equivalent tensile strengths and belt safety factors that are more than comparable to 3 or 4-layer conventional belting. Although finger splices may concern those who have no previous experience of making them, the technical and economic arguments in their favour are unquestionable. Finger splice joints are proven to be stronger and more durable so the need to repair and re-splice joints is almost non-existent. By comparison, it is estimated that some 80% of unplanned stoppages to carry out running repairs on multi-ply belts are the result of splice joint failure.



Less environmental impact – less energy, less rubber, less synthetic fabrics, less chemicals.

**BETTER FOR THE ENVIRONMENT**

The reduction in environmental impact is also considerable. Having only one or two layers rather than 3, 4 or more helps to maximise production efficiency and reduce energy consumption because there are fewer calender (layering) runs.

Fewer layers also mean that less rubber is used, including a corresponding reduction in the amount of chemicals and additives used to create that rubber. The dramatic reduction in the amount of non-biodegradable nylon and polyester used in the creation of a single layer of fabric compared to the multiple layers found in a conventional multi-ply belt is particularly important. Another key environmental benefit is that the vastly superior toughness of Ultra X and UsFlex belts means that they need to be replaced far less frequently, which consequently means that far fewer conveyor belts need to be manufactured in the first place and ultimately disposed of.

**A SINGLE AND DUAL-PLY FUTURE**

For some, the very idea that single and dual-ply belts can provide considerably more resistance to wear and damage compared to much thicker, heavier belts with multiple plies is difficult to comprehend. However, the evidence is overwhelming. UsFlex is long established while Ultra X, which has proved a great success since its launch some six years ago, is now the belt of choice on both sides of the Atlantic. With the Nova X single-ply, designed as a replacement for multi-ply belts such as 800 and 1000N/mm, about to be launched in the coming year, Fenner Dunlop clearly believe that single-ply and dual-ply belts are the future of industrial conveying belt and that less really can be more.

**Bob Nelson**

*(Authors note: I would like to express my gratitude to Fenner Dunlop and the many engineers and technicians who were so open and helpful during my research for this article)*