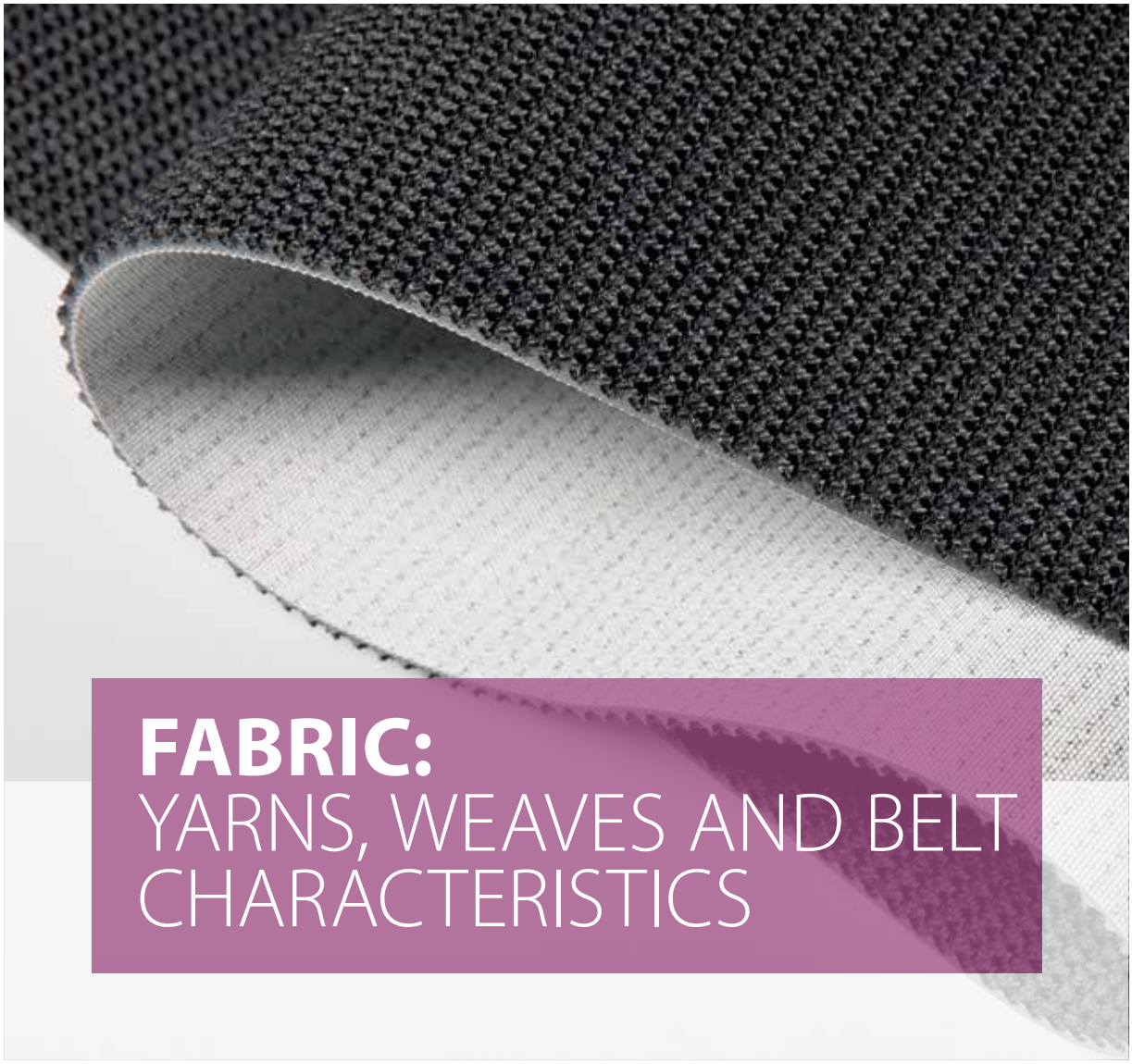
WHITEPAPER



FABRIC:
YARNS, WEAVES AND BELT CHARACTERISTICS

Siegling – total belting solutions

forbo
MOVEMENT SYSTEMS

Foreword

Forbo Movement Systems belts come with a variety of characteristics. They can have low or heavy surface weights, be thick or thin, flexible or rigid, slightly elastic or very elastic, conductive or non-conductive, reinforced or non-reinforced, and much more.

The process technology, tailored to each belt type, produces some of these characteristics and others are due to specific raw materials. These raw materials also include the fabric.

Many of the belts in the Transilon, Extremultus and Transtex product ranges have one or more layers of fabric to reinforce them.

In these cases, the fabric primarily acts as a tension member, but also helps to form other characteristics in the finished belt.

To understand some of the characteristics of conveyor belts better, yarn and fabric expertise is vital.

Whitepaper
Fabric: Yarns, Weaves and Belt Characteristics · 11/24

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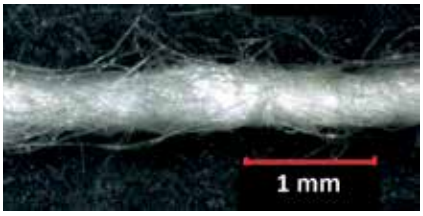
1 Yarn types

Staple fiber yarns, multifilament yarns and monofilament yarns are used for the fabrics in Transilon, Transtex and Extremultus belts.

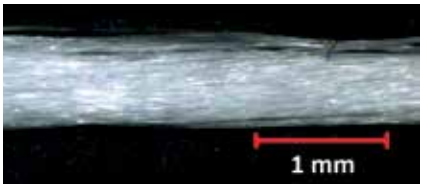
Staple fiber yarns (also: spun yarns) are made of many fibers of a certain length that are twisted together.
Staple fiber yarns have protruding fiber ends, which lend the yarn a hairy or fluffy look and feel. Because of this fluffiness, belts with underside fabric made of this yarn type tend to operate more quietly than those with fabric made of smooth yarns. Staple fiber yarns can be made of synthetic fibers (e.g. polyester – PET) and natural fibers (e.g. cotton). In the fabrics processed at Forbo, staple fiber yarns can be used both lengthwise and crosswise.



Microscopic image of a staple fiber yarn

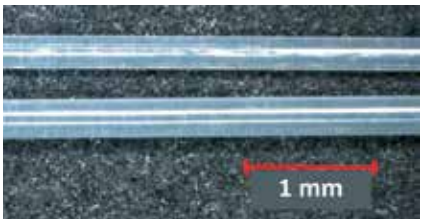
To produce filament yarns (multifilament yarns, monofilament yarns), liquid textile pulp is pressed (extruded) through spinnerets. The resulting filaments solidify and are stretched afterward.
Filament yarns are made from synthetic fibers only.

Multifilament yarns consist of a bundle of thin filaments,
which are often also twisted together.
Their smooth surface and superior tear resistance are two of multifilament yarns' special characteristics.
Fabrics made of or with multifilament yarns are used when, despite their thin coatings, smooth and seamless belt surfaces are required, or for many belt types that need to withstand higher forces.
Just like staple fiber yarns, multifilament yarns can also be applied in fabrics processed at Forbo both lengthwise and crosswise.



Microscope image of a multifilament yarn

Monofilament yarns are single, thicker filaments that aren't twisted.
Stiffness is the monofilaments' most important characteristic.
Due to their stiffness, monofilaments in fabrics processed at Forbo are only used crosswise.
Fabrics with crosswise monofilaments increase the lateral stiffness of the belt.

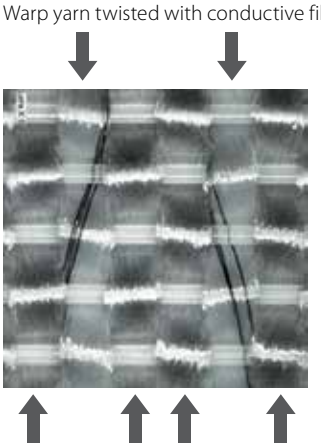


Microscope image of two monofilament yarns with different diameters

2 Conductivity

For some applications, Forbo belts need to be conductive. This conductivity can be achieved via conductive elements in the coating or in the fabric.

One way of producing a conductive fabric is to add conductive filaments to the fabric. As these filaments are frequently much thinner than the other yarns, they're usually twisted with the other yarns.



3 Weaves

A woven fabric is created when lengthways and crosswise threads intersect.
The lengthwise ones are called warp threads (or warp) and the crosswise ones weft threads (or weft).
At each intersection, the warp can be threaded over or under the weft.
The different ways the warp and weft interlace with each other are called weaves.

The fabrics processed at Forbo can have different weaves, some of which depend on the product group they are destined for.
For instance, fabrics with a plain weave are often used for Transilon products, while multi-layer fabrics (interwoven) are often used for Transtex products.

There is a rough distinction between single-ply fabrics, which include plain weave and twill weave, and multi-ply fabrics.
This distinction between single-ply and multi-ply fabrics has nothing to do with single-layer and multi-layer belts. A two- or three-ply belt can consist of single-ply fabrics, just as a single-ply belt can consist of a multi-ply fabric.

3.1 Plain weave

In plain weaves, each warp thread passes over and under each weft thread in an alternating manner, just as each weft thread passes over and under each warp thread in an alternating manner. Therefore, warp and weft threads are most closely interlaced in plain weaves.
Fabrics with plain weaves are particularly flexible and therefore often used for belts destined for knife-edges.
Forbo belts are made of lots of plain weave fabrics, which differ in terms of the yarn (yarn type, yarn material and yarn fineness) and thread count.

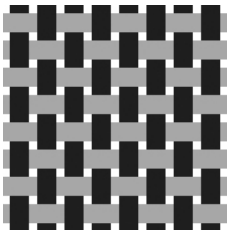
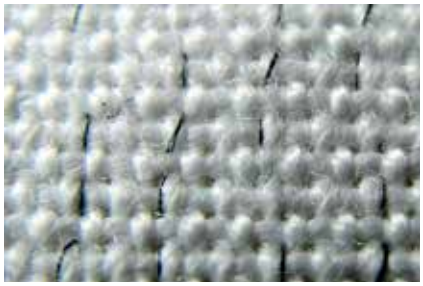


Diagram: Plain weave

Fabric with plain weave
Warp: Multifilament yarn + conductive filaments
Weft: Monofilament yarn



Fabric with plain weave
Warp: Staple fiber yarn + conductive filaments
Weft: Staple fiber yarn

Fabric with plain weave
Warp: Multifilament yarn
Weft: Multifilament yarn

3.2 Broken twill weave

Twill weaves are produced by a crisscrossing of threads that result in a pattern like a staircase. This creates parallel, diagonal lines in the fabric (twill line).
The twill line can rise to the left (left-hand twill), to the right (right-hand twill),or alternately to the left and right.
Forbo's belts are almost exclusively made of twill weaves which are an even mix of left-hand and right-hand twill.

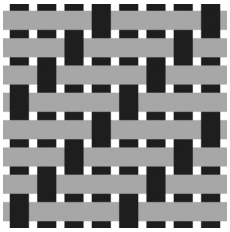


Diagram: Twill weave;
right-hand twill

One such twill weave which is an even mix of left-hand and right-hand twill is broken twill..
3x1 broken twill weave also stands apart because the warp threads are primarily on one side of the fabric (warp float). Therefore, fabrics woven like this have two very different sides. The side with warp floats feels smooth in a lengthways direction, whereas the other side feels rough in a lengthways direction. If a fabric of this type is used, with its smooth side facing downwards, as a conveyor belt's bottom fabric layer, it can cut noise.
Just as with plain weave fabrics, fabrics with broken twill weave can have different characteristics due to the individual selection of yarns and thread counts.

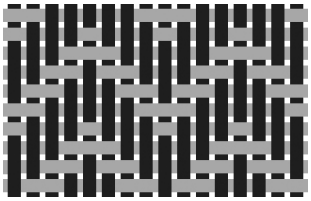


Diagram: Pointed twill weave;
alternately left-hand and right-hand twill

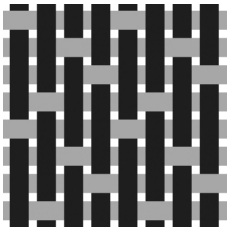
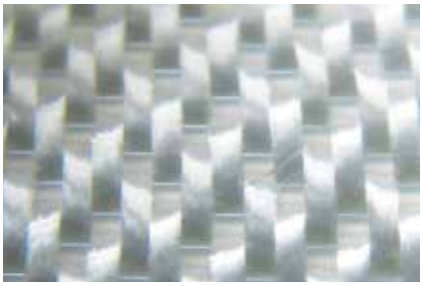


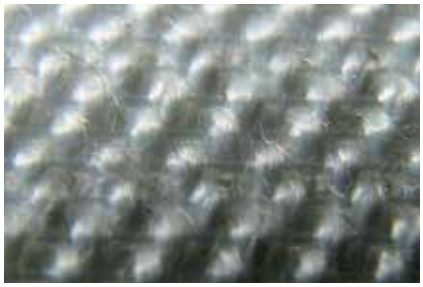
Diagram: Broken twill weave 3/1;
alternately left-hand and right-hand twill



Fabric with 3/1 broken twill weave
Warp: Multifilament yarn
Weft: Monofilament yarn
smooth side

Fabric with 3/1 broken twill weave
Warp: Multifilament yarn
Weft: Monofilament yarn
rough side

Fabric with 3/1 broken twill weave
Warp: Staple fiber yarn
Weft: Monofilament yarn
smooth side

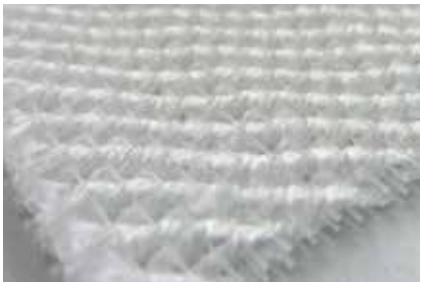


Fabric with 3/1 broken twill weave
Warp: Staple fiber yarn
Weft: Monofilament yarn
rough side

3.3 Multi-layer fabrics/interwoven fabrics/solid woven fabrics

Apart from single-ply fabrics such as the plain weave or twill weave families, there are also fabrics with two or more layers of warp threads and/or two or more layers of weft threads.
These fabrics are usually referred to as multi-layer fabrics. The multi-layer fabrics in many Transtex PVC types and all Transtex PVK types are also known as interwoven and solid woven fabrics.

The family of multi-layer fabrics includes a variety of weaves and fabric designs. All multi-layer fabrics processed at Forbo are much thicker and more robust than single-ply fabrics.



Multi-layer fabric used in Transilon types

Multi-layer fabric used in Transilon types

Multi-layer fabric used in Transtex types
(interwoven fabric)

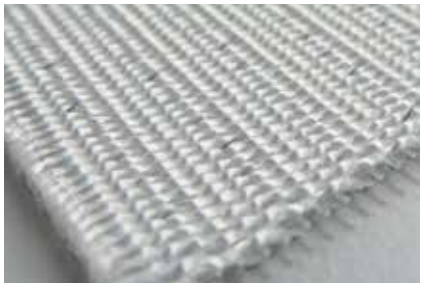
3.4 HighTech fabrics

HighTech fabrics (H-fabrics) are a special type of multi-layer fabrics.
Fabrics from this weave family were originally developed with a fabric supplier and have been used for Transilon H-types as well as some Extremultus types for many years.

Due to the tension member warp on the inside, H-fabrics are comparatively stronger than fabrics with other weaves.
Forbo uses various H-fabrics, which differ from each other particularly in terms of the yarns.

H-fabric cross-section
red: Tension member warp
gray: Binding warp
blue: Weft

H-fabric
Tension member warp: Multifilament yarn
Binding warp: Staple fiber yarn
Weft: Multifilament yarn



H-fabric
Tension member warp: Multifilament yarn
Binding warp: Multifilament yarn
Weft: Monofilament yarn

4 Materials

The yarns in most Transilon, Transtex or Extremultus products are made of PET, polyamide, or aramid. Fabrics with cotton yarn are also used for special belt types.

4.1 PET

PET (polyethylene terephthalate) is a polyester, i.e. a synthetic fiber.
PET can be used to produce staple fiber yarns as well as multifilament or mono-filament yarns.
PET yarns stand apart for their exceptional strength and therefore outstanding durability, their high melting point and low moisture absorption.
In addition to yarns made from conventional PET, yarns made from recycled PET (recycled PET bottles) are also available.

4.2 Polyamide (nylon)

Polyamide (PA) is also a synthetic fiber.
The nylon yarns in the fabrics processed by Forbo are made primarily from PA 6 and PA 6.6.
Polyamide yarns are very strong and exceptionally resistant to abrasion.
Polyamide fabrics are mainly used in Extremultus belts.

4.3 Aramid

Aramid is also a synthetic fiber.
Textiles made of meta-aramid (m-aramid; well-known brands: Nomex, Conex) are primarily used for fire safety applications due to their excellent flame and heat resistance (for instance, they are ideal for fire fighters' fireproof clothing).
In Transilon conveyor and Extremultus belts, on the other hand, fabrics with para-aramid yarns (p-aramid; known brands: Kevlar, Twaron) are used, due to their superior tensile strength, for special applications.
Compared with PET yarns that are just as fine (in terms of thread thickness), para-aramid yarns have about three times the maximum tensile strength and more than six times the strenght at 1% elongation.
However, para-aramid yarn is also significantly more expensive than PET yarn.
Para-aramid yarns are easy to identify because they are yellow when undyed.

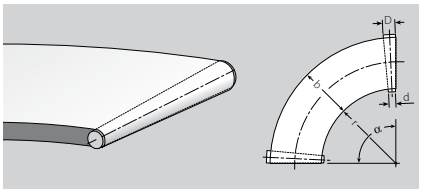
5 Application examples

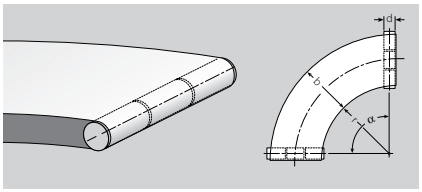
5.1 Laterally stiff/laterally soft conveyor belts

Depending on the requirements, conveyor belts need different levels of lateral stiffness.
Lateral stiffness makes a belt lie flatter and hampers the formation of undulations and creases. As a result, this characteristic is essential for very thin and wide belts.
Laterally soft conveyor belt material, on the other hand, can be used when troughability is required.
The degree of a conveyor belt's lateral stiffness is determined by the thickness and type of coating as well as the lateral stiffness/softness of the underlying fabric(s).
Soft, flexible yarns, i.e. staple fiber yarns or multifilament yarns, in the weft produce laterally soft fabrics, while hard, stiff yarns, i.e. monofilament yarns, in the weft produce laterally stiff fabrics. Fabrics are particularly laterally stiff when monofilaments with a very large diameter are used in the weft.

5.2 Curved belts

Circular ring segments are cut from conveyor belt material and joined for use as curved belts.
During conveying, the circular ring segments are rotated around their theoretical center point so that the original lengthwise direction eventually becomes the lateral direction and then the lengthwise direction again.
Therefore, fabrics with very similar longitudinal and lateral characteristics are required.
Fabrics chiefly used for curved belts are laterally soft; multifilament yarns are used in the warp and weft because they are stronger. In these fabrics, the warp and weft are made of yarns that are equally fine (thread thickness) with the same similar settings (number of threads per unit of length).





5.3 Belts with fabric and aramid yarn

Belts of exceptional tensile strength are required for certain applications. Special fabrics are used as tension members to give a belt this characteristic.
Aramid yarn in the warp ensures superior tensile strength lengthways, PET yarn in the other thread systems (weft, possibly binding warp) ensures fabric cohesion and cuts costs.
If these types of belts have additional fabric layers, these are usually also made of PET.

6 Conclusion

It's not just criteria like the coating material or surface pattern that governs which belt to choose. It's precisely the processed fabric that has a significant impact on the end product's characteristics. Not only the weave, but also the yarn type, yarn material, yarn count and thread count in warp and weft are paramount.

For example, yarn types such as monofilament yarn create stable fabrics and yarn materials, yarn types such as aramid warp yarn produce very strong fabrics. Fabric designs with exceptional longitudinal and lateral flexibility are ideal for curved belt applications. Fabric designs that are very flexible in a longitudinal and very stiff in a lateral direction are perfect as knife edge belts.

The belting solution will only meet the application's requirements and last for a long time once all belt and fabric factors have been taken into account.

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