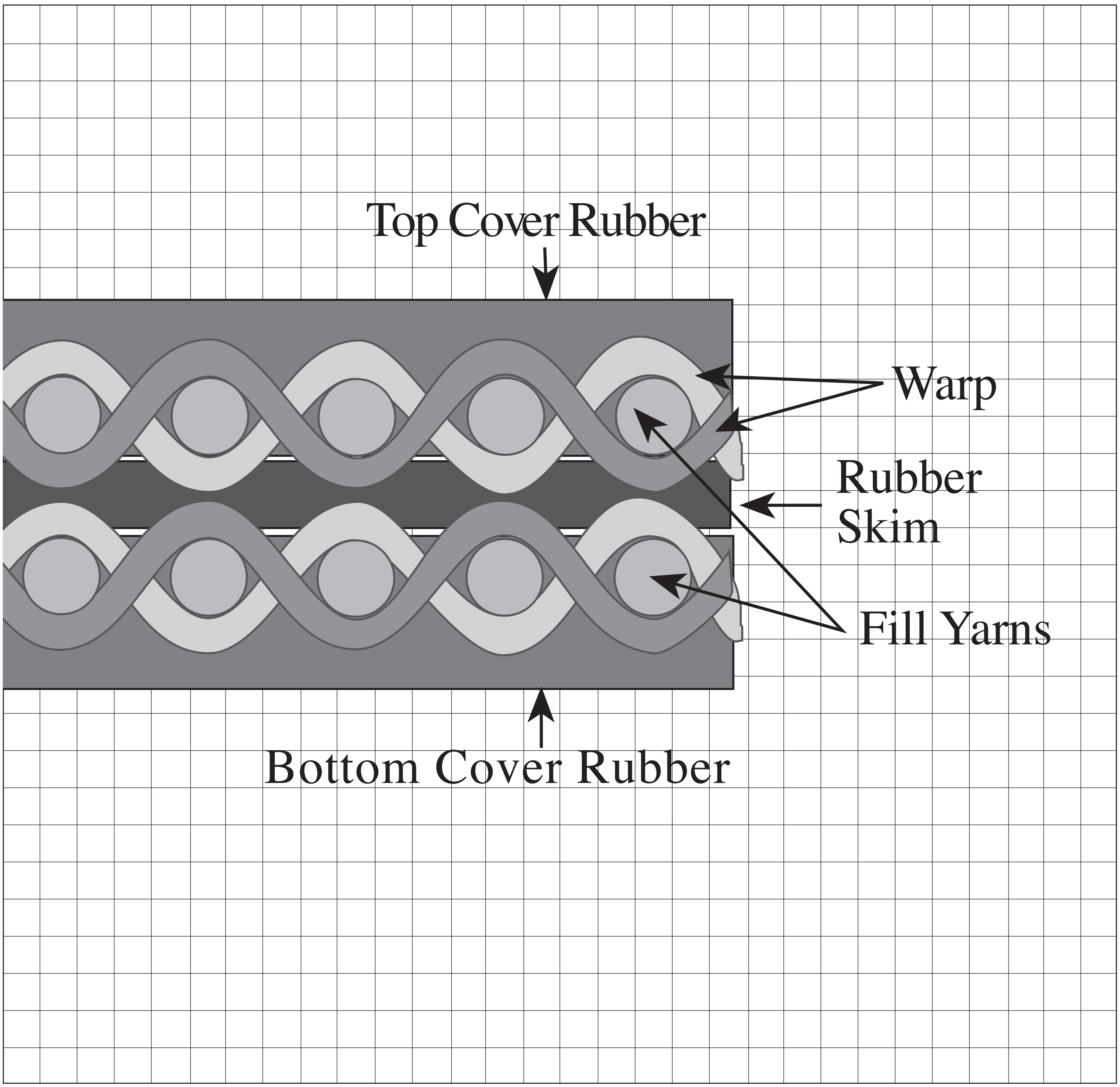
Index Page

FENNER DUNLOP
CONVEYOR BELTING

Conveyor Belt Construction



Index Page

Conveyor belts generally are composed of three main components:

1. Carcass
2. Skims
3. Covers (carry cover and pulley cover)

Carcass

The reinforcement usually found on the inside of a conveyor belt is normally referred to as the "carcass." In a sense, the carcass is the conveyor belt since it must:

1. Provide the tensile strength necessary to move the loaded belt.

2. Absorb the impact of the impinging material being loaded onto the conveyor belt.

3. Provide the bulk and lateral stiffness required for the load support.

4. Provide adequate strength for proper bolt holding and/or fastener holding.

The carcass is normally rated by the manufacturer in terms of "maximum recommended operating tension" permissable (pounds per inch i.e., ppi)

Similarly, the manufacturer rates the finished belt in terms of "maximum recommended operating tension" per inch of width (which is the total of the preceding, multiplied by the number of plies in the belt construction) i.e., 4 plies of 110# fabric = a 440 pound per inch of width (PIW) working tension belt.

The manufacturer determines the maximum recommended operating tension per inch of width with considerations given to:

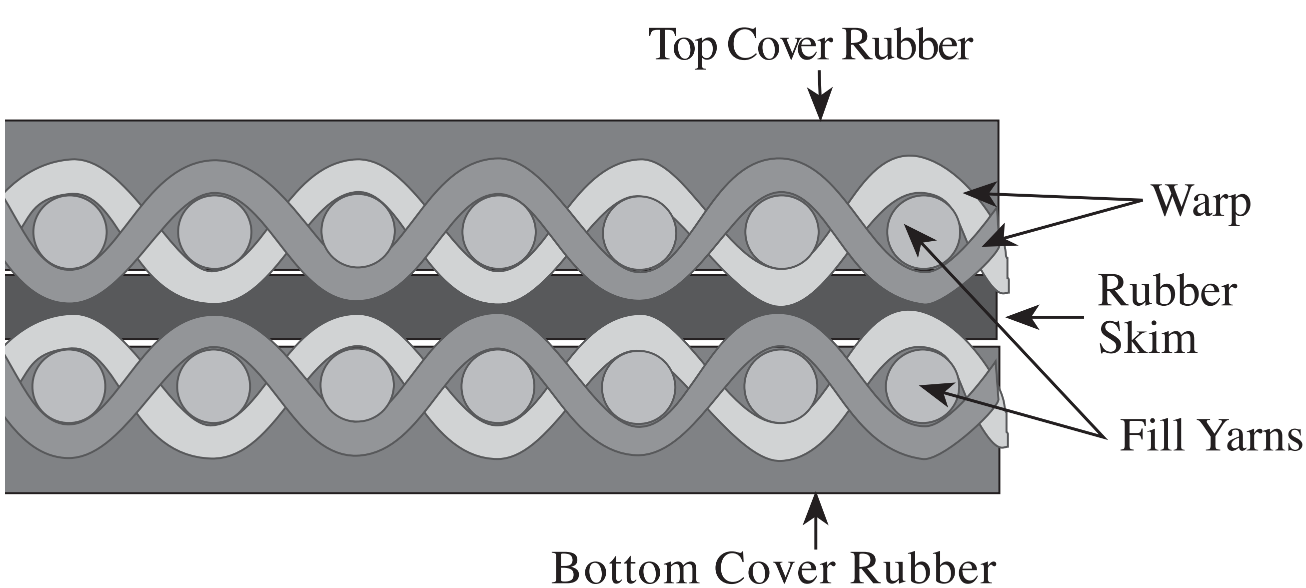
1. Stretch characteristics of the belt.
2. Fastener/bolt holding capability.
3. Load characteristics.
4. Stiffness.
5. Impact resistance of the belt construction.

There is a relationship between the recommended maximum operating tension per inch of width of the belt and the ultimate tensile strength (breaking strength) of the belt which will be explained later.

Carcass Design

Multi-Plies + Elastomer = Plylok Supreme
Plylok, PHR and PRL

The most common carcass design is made up of layers or "plies of woven fabrics bonded together (see Illustration below). This "conventional plied" belt construction, generally employs a plain weave or twill weave carcass which is built up into

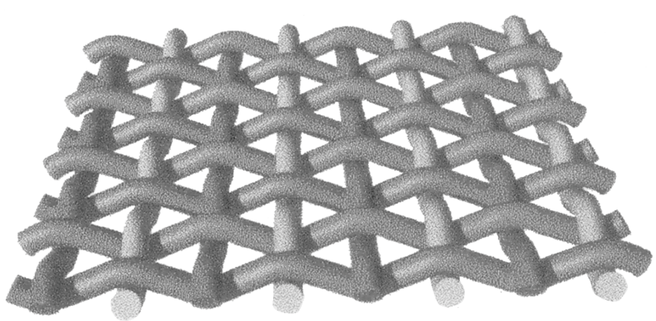


Index Page

as many layers as is required to provide the necessary belt strength…usually bound together with rubber.

In the “plain weave,” the “warp yarns” (lengthwise yarns) and the “fill yarns” (crosswise yarns) pass over and under each other. This means that both members are “crimped” (Essentially, each assumes a sine-wave-like configuration). This fact, plus the basic characteristics of the fiber used give the belt its stretch characteristics.

Conventional plied carcass belts have been used for decades. Consequently, they are the most common belt design used today. Most conveyor engineers and millwrights are familar with conventional plied belting constructions and their characteristics. Virtually, all belting mechanics know how to “splice” conventional plied belts. This familiarity with the belt’s characteristics and the “ease of endlessing” gives the conventional plied belting design its broad customer acceptance.



When cotton and similar materials were widely used as carcass components in plied belts, a breaker strip, an additional layer of open weave fabric was added between the carcass and the top cover for heavy abuse constructions, helping absorb the loading impact. The switch to modern synthetic carcass materials (like polyester and nylon) has essentially eliminated the need for the breaker strip. Today, breaker strips are seldom found in plied belt constructions except in extreme impact applications.

Conventional plied belting constructions, employing all synthetic carcasses and elastomer covers appropriate to the end use, are particularly recommended for:

I. Hard Rock Mining
   (A) Aggregate, sand and ore
II. General purpose applications
III. Forest products
IV. Soft Minerals
   (A) Coal
   (B) Potash, Phosphates
   (C) Grain
V. Unit Handling
   (A) Parcels
   (B) Baggage
   (C) Mail

Skims

The rubber, PVC or urethane between plies is called a “skim.” Skims are important contributors to internal belt adhesions, impact resistance, and play a significant role in determining belt “load support” and “troughability.”

Improper or marginal “skims” can adversely affect belt performance in general and can lead to ply separation and/or idler junction failure.

Straight Warp Wearlock, Kordlok, PVK, PHR

The straight warp carcass design yields a carcass construction wherein the basic lengthwise (warp) yarns are essentially uncrimped. These are the main load-carrying tension yarns. Fill yarns are then laid transversely and alternately, above and below the main tension yarns. This construction gives greater dimensional stability to the belt, and does employ a “beam" effect for better load support and transverse rigidity.

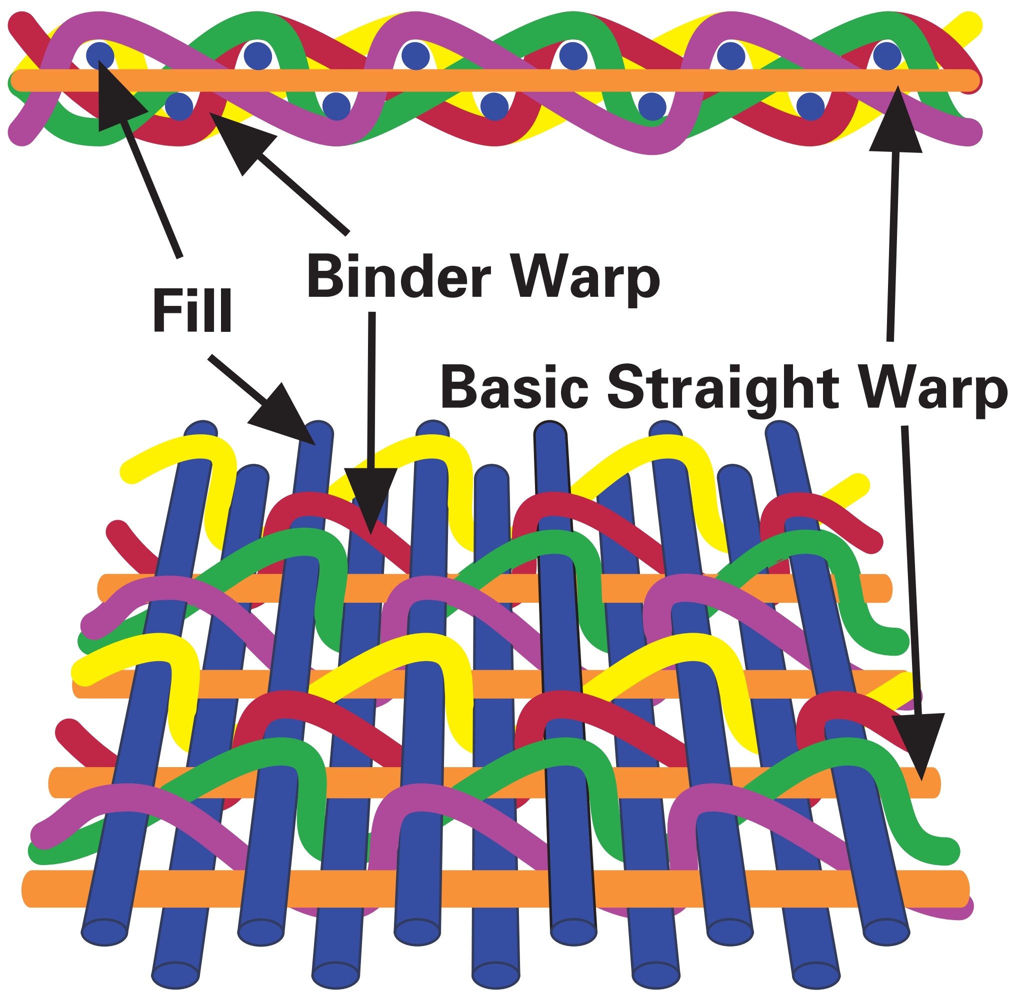
The yarns used are much thicker than yarns in conventional fabrics. Further, they are locked together by means of another series of lengthwise yarns, known as the binder warp system. The binder warp system locks the tension and fill cords tightly together, creating a belt which is unusually tough and which has exceptional tear and impact resistance, as well as good fastener and bolt holding ability.

The straight warp configuration for the basic tension yarns essentially eliminates “geometric stretch” and results in a conveyor belt construction with a minimum stretch characteristic. . .a significant advantage in most conveyor belt applications.

Straight Warp constructions are used for:

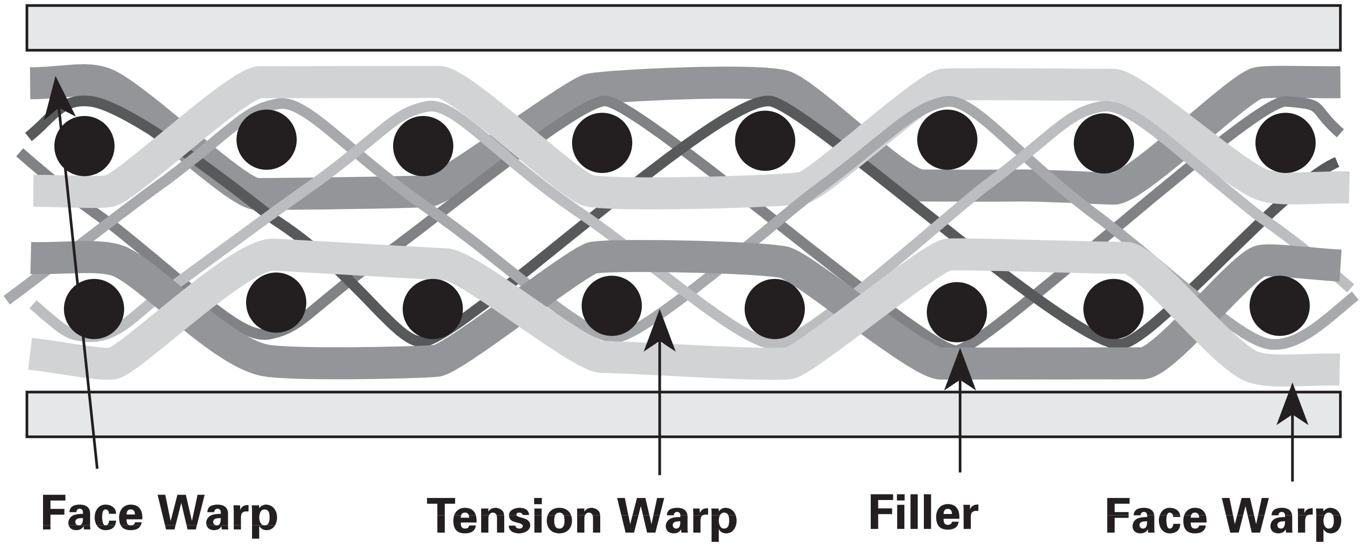
I. Hard Rock Mining
(A) Aggregate, sand and ore
(B) High impact applications
II. General purpose applications
III. Soft Minerals
(A) Coal
(B) Potash, Phosphate
(C) Grain
IV. Unit Handling
(A) Parcels
(B) Baggage
(C) Mail

STRAIGHT WARP



Index Page

Solid Woven Carcass



PolyVinylok utilizes a Solid Woven Carcass with PVC and Spun Polyester Binder Warp (Face Warp) and PVC and Filament Polyester Tension Warp. The filament offers High Tenacity–Low Stretch and both yarns have Moisture-Acid-Oil Resistant properties.

The solid woven design can be considered an extension of the straight warp concept. Polyester filament yarns, as well as spun polyester staple yarns, are coupled in a highly complex fabric construction, which is somewhat similar to the straight warp. However, because of the high performance requirements of these constructions, more than one layer of basic, warp yarns are used. The whole is interlocked and tied into one single mass by means of a uniquely designed binder warp system. Spun polyester staple yarns protect the two faces of the carcass construction and combined with the high performance PVC, form the working surface of the belt itself.

PolyVinylok, a single-ply conveyor and elevator belting construction, has found wide acceptance in:

1. A broad range of industrial applications;
2. Agricultural equipment;
3. Food processing;
4. Grain handling (conveyor and elevator);
5. Underground mining, such as coal, potash, and other soft minerals;
6. Forest products.

Steel Cord + Rubber

Steel Cord-type constructions utilize a single layer of uniformly tensioned steel cords as strength members; encased in rubber. Steel cord belts are generally found in high tension applications ranging from 600 PIW to 5,000 PIW and/or where extremely low stretch is a necessity. Typical elongation for steel cord conveyor belting is less than 1/3 of 1%. Steel cord belts must be manufactured to width.

Strength Designations

In the past, when cotton was the primary fabric for carcass construction, all fabrics were designated by the weight of a piece of fabric 42" X 36", i.e., in cotton 28 oz., 32 oz. Duck, etc. As new carcass materials were developed that varied in strengths and weights, new methods of designation were required. As a general rule, current fabrics in use are designated by the working tension or strength of the fabric, shown in pounds per inch of width (PIW), i.e.25, 45, 80, 110, 125,150, 200, 250 and 300 pound fabrics, etc.

When dealing with carcass fabrics, we work with two separate strength measurements. The first is the **Maximum Working Tension** or strength of the belt. This is the highest tension occurring in any portion of the belt on the conveyor system, under normal operating conditions. This is the strength measurement used to determine the proper belt for the system. The second measurement is the **Ultimate Tensile Strength** of the belt. The ultimate tensile strength of a belt is the point at which that belt will rupture and fail due to excessive tension.

The difference between the maximum working tension and the ultimate tensile strength of the belt is often referred to as the “service factor.” On top quality domestic conveyor belting, this service factor is 8-10 to 1. Most Georgia Duck belting has a 10 to 1 service factor. This means that if the maximum working tension is 200 PIW, the ultimate tensile strength would be 2,000 PIW. Belting utilizing nylon constructions generally has a service factor of more than 10 to 1. This higher service factor is necessary to overcome some of the inherent properties of nylon, such as excessive elongation.

Most conveyor belt fabrics are produced today with polyester warps (lengthwise yarns) and nylon fills (widthwise yarns). This combines the best properties of both textiles offering high strength, low stretch conveyor belt with excellent impact resistance, troughability, load support, and fastener and/or bolt-holding ability.

Materials - Fibers

Carcass materials used in belt manufacture in recent years are listed as follows. Given is the common name, the composition and some general comments about each material. (Please note their characteristics and current position in the market place)

Cotton **Natural Cellulose Composition**

Only natural fiber used to any great extent in belting manufacture. Increases in strength when wet. High moisture absorption - consequently, poor dimensional stabilty. Susceptible to mildew attack. At one time represented 80% of the raw fiber input into belt manufacture. Currently, something less than 5%.

Rayon **Regenerated Cellulose Composition**

Slightly stronger than cotton, but tensile strength is lowered by water. Chemical resistance similar to cotton. High moisture absorption - consequently, poor dimensional stability. Susceptible to mildew attack. Almost nonexistent in conveyor belt today.

Glass **Glass**

Very high strength compared to rayon. Low elongation. Mainly used in high temperature applications. Poor flex life. Limited use in belt manufacture currently.

Nylon **Polyamide**

High strength, high elongation, good resistance to abrasion, fatigue and impact. While moisture absorption not as high as cotton, it will absorb up to 10% of its own weight in moisture. Consequently, poor dimensional stability. High resistance to mildew. At one time, nylon represented 40% of the raw material input into belt manufacturing. Today, it is something less than 20%.

Polyester **Polyester**

High strength, exceptionally good abrasion and fatigue resistance. Extremely low moisture absorption. . .consequently good dimensional stability. Unaffected by mildew. Georgia Duck selected polyester as its “fabric of choice” in 1960. Polyester usage in the manufacture of belting has grown from 0% in 1960 to something in the range of 70-75% today. (See Georgia Duck technical data bulletin “Polyester, The Fiber of Choice”).

Steel **Steel**

Used where high strength and extremely low stretch are a necessity. A small amount of woven steel carcass is found in today’s market. However, more steel is used in steel cord-like belt constructions.

Kevlar **Aramid**

Aramid (the material used in flak jackets and bullet-proof vests) has twice the strength of steel, with stretch characterisitics roughly halfway between steel and polyester. It is significantly lower in weight than steel and will not rust.

Covers

Covers are used in conveyor belt constructions in order to protect the base conveyor belt carcass and, if possible, to extend its service life. In addition, covers do provide the finished belt with a wide variety of desirable properties, including the following:

A. Textures
  To increase friction
  To increase inclination
  To control product
B. Cleanability
C. A specific coefficient of friction
D. A specific color
E. Cut resistance
F. Enhanced impact resistance, etc.
G. Hardness
H. Fire Resistance, Oil & Chemical Resistance

Cover type, quality and thickness are matched to the service life of the belt involved. A specific cover formulation used in an individual belt construction is determined by the material to be carried and the environment in which the belt will operate.

Historic belt constructions were highly susceptible to moisture and chemical attack because of their cotton carcass components. Accordingly, it was common to extend the belt covers over the edges of the belt in what is known as the "molded edge" construction. This type of manufacturing can be expensive because of the additonal labor and machine time involved.

Modern day belt constructions, with their high adhesion levels and synthetic carcasses, are considerably less susceptible to moisture and chemical attack, and do not require edge protection. They make possible the "slit-edge belt distribution" programs currently used in the Belting Industry. Costs are minimized since an 84" slit-edge belt can be manufactured about as quickly (if not more so) as a 24" molded edge construction. Further, the labor involved is somewhat less.

Georgia Duck uses an extremely wide variety of polymers for our cover needs, including: Polyvinylchloride, natural rubber, various synthetic rubbers and urethane - - to meet individual customer needs. Quality competitors offer covers made of similar polymers although their individual "recipe" may be somewhat different. Individual cover formulations are usually blends consisting of one principal polymer and assorted modifiers, such as other polymers, antioxidants, accelerators, curatives, pigments, extending and reinforcing fillers, plasticizers, etc.

Specific conveyor belt applications seldom require the belt cover to satisfy one or two conditions. More usually, a broad variety of required and desired properties are encountered. The specific cover formulation is quite likely to be a compromise, which seeks to meet the customer's criteria and still remain cost effective. For many applications, the blending of polymers adds properties that could not be obtained in a single polymer compound.

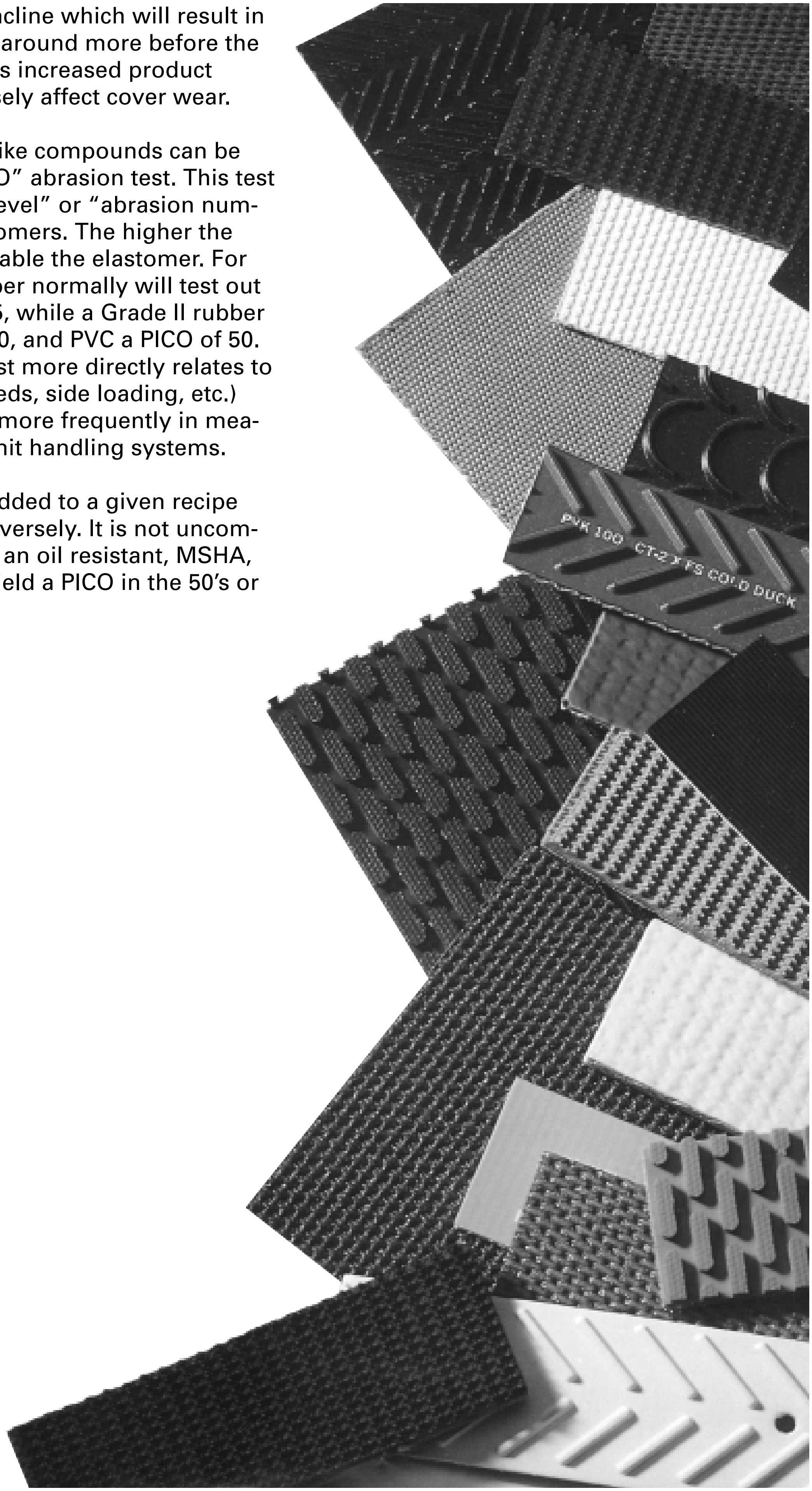
The Georgia Duck Chemical Resistance Chart lists characteristics of many belt covers offered by Georgia Duck. Specific compound properties are detailed as is chemical resistance. This list is an important assist in selecting proper cover compounds.

In addition to selecting proper compounds for cover material, it is also necessary to determine the proper cover thickness. The thickness of a cover is influenced by the amount of abuse and wear the belt will receive. The cover is usually the lowest cost component of the belt.

The severity of the wear depends on the nature of the material and on the size, weight, shape and trip rate of the material conveyed. Sharp edges, particularly on large pieces, can quickly cut a cover badly. On the other hand, if loading conditions are ideal, with the material being loaded in the direction of travel of the belt, and with only a slight impact onto the belt, even very sharp material may not seriously cut or wear the belt surface. Cover wear is also influenced by the loading area being on the horizontal compared to loading a conveyor belt on an incline which will result in the product bouncing around more before the load settles down. This increased product movement will adversely affect cover wear.

Wearability of rubberlike compounds can be characterized by “PICO” abrasion test. This test assigns “wearability level” or “abrasion numbers” to various elastomers. The higher the number, the more durable the elastomer. For example, Grade I rubber normally will test out at a PICO rating of 135, while a Grade II rubber will yield a PICO of 100, and PVC a PICO of 50. The Taber abrasion test more directly relates to sliding wear (slider beds, side loading, etc.) and is therefore used more frequently in measuring belts used in unit handling systems.

Fillers and additives added to a given recipe can affect the PICO adversely. It is not uncommon, for example, for an oil resistant, MSHA, rubber elastomer to yield a PICO in the 50’s or 60’s.



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