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MINING & QUARRY WORLD



Between a rock and a hard place



RUBBER CONVEYOR BELTS – HOW AND WHY DIFFERENT BELT TYPES ARE NEEDED FOR DIFFERENT TYPES OF ROCK.

Many different types of rock are mined and quarried throughout the world and each type has its own properties and characteristics such as relative hardness and sharpness for example. Added to this is lump size and weight, which is more influenced by mining methods and handling stages rather than the geological origin.

However, whereas rocks and the type of damage they can cause to conveyor belts has never changed, conveyor belt technology has fortunately advanced enormously in recent years. This progress is mainly due to the pioneering efforts of leading vehicle tyre manufacturers such as Michelin in France (owners of Fenner Dunlop Conveyor Belting) and Continental in Germany. Their constant quest for even greater tyre safety and durability (longevity) continues to directly benefit their production of other rubber products including conveyor belts. As a result, it is now possible to select rubber compounds that are best suited to the characteristics of the rock being handled.

ONE TYPE DOES NOT SUIT ALL

When considering the selection of a conveyor belt, the very first item on the selection criteria should be the type/grade of rubber covers needed based on the characteristics of the material being conveyed. The quality (durability) of the rubber cover is often the single biggest factor affecting conveyor belt service life and consequently, it's cost-effectiveness. Although the low prices offered for imported 'economy' belts may seem very tempting, the reason for low prices is because



Conveyor belt technology has advanced enormously in the past 20 years.

rubber can represent some 50% of the cost of making a conveyor belt, so it is the prime target for using cheap, low grade raw materials.

The key point here is that the initial price of a belt represents only a fraction of the total spending (cost) over its lifecycle when the frequency of replacement due to wear and tear and the frequency of stoppages to carry out repairs to damaged covers are taken into consideration.

ROCK TYPES

The three main categories of rock are igneous, sedimentary, and metamorphic. Their hardness and sharpness depend entirely on their mineral composition and how they were formed. Hardness is measured on the Mohs Hardness Scale (1 to 10), while sharpness depends on a rock's grain size and how it breaks (fractures).

Igneous Rocks were formed from cooled molten rock. They are generally dense and lack natural layers. Many igneous rocks are known for their hardness (5 to 7+) and Abrasivity qualities*. Their sharpness is variable but volcanic glass (Obsidian) fractures smoothly to create edges that can be sharper than surgical steel. Coarser, more abrasive rocks such as Granite break into rough, dull chunks. (* Abrasivity describes the ability of rocks (minerals) to wear (frictionally) the surface of solid materials such as rubber and steel).

Sedimentary Rocks (Soft to Brittle) were formed from accumulated debris compressed over millions of years. Hardness is generally low to medium (1 to 5). Sharpness is mostly poor. They crumble into grainy pieces rather than breaking cleanly. However, microcrystalline quartz varieties such as Flint and Chert (Hardness: 7) break with razor-sharp edges, which is why prehistoric humans used them for arrowheads.

Metamorphic Rocks (Tough, consisting of plates or flaky layers) originate from pre-existing rocks altered by extreme underground heat and pressure. Hardness rated as medium to extremely hard (3 to 7+). While Marble is relatively soft, Quartzite is incredibly hard and tough to break. Moderate to high sharpness. Many metamorphic rocks such as Slate or Schist split along flat, parallel planes (foliation). This creates flat, blade-like sheets with moderately sharp edges, although they lack the razor-edge performance of glass or flint.



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'Chunking' – surface cuts propagate, causing chunks of rubber to detach completely.

THE SCIENCE BEHIND THE RUBBER

Until relatively recently, the rubber covers used on conveyor belts were all broadly similar. However, advances in rubber technology mean that synthetic rubber compounds can now be engineered to better withstand different types of aggressive materials. Each manufacturer uses its own recipe (mix) of polymers to create cover compounds with specific wear resistance qualities. The main polymers used are SBR (Styrene-Butadiene-Rubber), which is a synthetic rubber and NR (Natural Rubber).

In basic terms, SBR has good general resistance to abrasive wear while natural rubber has better resistance to surface cutting, gouging, 'chunking' *(Surface cuts that propagate and link up with other areas of damage, causing pieces of rubber to detach completely)* and crack propagation. Consequently, natural rubber is often an important component of premium DIN X compounds. Unfortunately, it is appreciably more expensive so many manufacturers try to avoid or at least minimise the amount of natural rubber used in order to achieve more attractive prices.

The reinforcing filler systems are equally important. Carbon black typically represents a substantial proportion in the range of some 20% of rubber volume and its quality has a major influence on wear performance. Depending on the formulation, it can be among the most significant contributors to the cost of the compound. Once again, cost dictates the quality so manufacturers who compete for market share based on lowest price are often found to reduce the amount of carbon black and use clay or chalk as substitute fillers.



DIN 53516 / ISO 4649 abrasion resistance testing



More than 50% of tested belts are significantly below the claimed minimum standard.

QUALITY STANDARDS

There are two internationally recognised sets of standards for abrasion, ISO 14890 (H, D, and L) and DIN 22102 (Z, Y, W, and X). The longer-established DIN standards are usually the preferred reference in Europe.

DIN Y (ISO 14890 L) is by far the most commonly used, with a maximum volume loss under DIN 53516 / ISO 4649 testing of 150 mm³. There is no direct equivalent ISO standard. The nearest is ISO 14890 L, but it is a much lower cover class than DIN Y in several respects including abrasion, tensile strength and elongation.

DIN X (ISO 14890 H), with a maximum volume loss standard of 120 mm³, is more versatile because it also incorporates good resistance to cutting, impact (from high drop heights) and the gouging that is often caused by heavy, sharp materials.

DIN W (ISO 14890 D) is generally regarded as the highest-performance cover grade for severe abrasive and mechanical wear conditions, including cutting, gouging, ripping, tearing and impact. Intended for the most aggressive applications/materials, it has a maximum volume loss standard* of 90 mm³. (* Lower figures represent superior resistance to abrasive wear whereas higher figures represent a greater loss of surface rubber and therefore a poorer resistance to wear. A belt with good abrasion resistance can often run for longer than the combined working life of two or even three lower grade 'economy' belts).

DIN and ISO standards not only relate to abrasion resistance because each standard also includes minimum required levels of tensile strength and elongation at break. In order to be classified, rubber covers must meet all three stipulated physical properties.

It is important to bear in mind that DIN and ISO standards are only the minimum benchmark of acceptability. Even then, although claimed as being a certain grade by the manufacturer, laboratory tests consistently reveal that more than 50% of tested conveyor belts are found to be significantly below the minimum standards required.

Even if a belt does marginally meet the required standard, manufacturers using higher quality rubber compounds can produce a significantly higher level of resilience to the point that one manufacturer's DIN Y grade belt can outperform another manufacturer's DIN X grade belt by a considerable margin.

CONCLUSION

Physical characteristics such as hardness, sharpness and abrasivity can differ quite considerably within each category of rock so it is not possible to allocate a definitive quality standard to each type. Selection must therefore be made based on characteristics rather than an 'umbrella' category/type. For example, a sedimentary rock such as flint with razor-sharp edges demands different rubber properties such as DIN X (ISO 14890 H) compared to 'fine' sedimentary rocks such as aggregate, sand and gravel, for which DIN Y (ISO 14890 L) would most probably be the best choice. Likewise, for any rock that is particularly hard, abrasive, sharp and/or heavy (in other words, the most severe working environments) then DIN W (ISO 14890 D) covers are most likely the best choice.

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