Heart OF STEEL

Marco Taddio, SIG SpA, Italy, considers the advantages provided by rubber conveyor belts with a fabric-like steel core.

Introduction

Over the years, much has been said about the evident advantages of bulk solids handling by means of conveyor belts, including low operating and maintenance costs, as well as high performances. The aforementioned topics gave this handling system an advantage over other systems, such as tyre tracks, trains, etc., which are more expensive and less efficient.

For many years, SIG SpA has been producing and providing its customers with a product named Siderflex® thanks to its strict and extended cooperation with Bekaert, which creates varied products based on high quality steel wires.

Siderflex® is not a simple steel cord conveyor belt, but an innovative product that distinguishes itself for quality, performance and flexibility of use (Figure 1). At the heart of Siderflex® belts is a steel carcass known as Fleximat®, produced by Bekaert in a dedicated plant in Europe, within a complete technological cycle starting from basic iron and steel products.

The history of Fleximat® began more than 30 years ago when Bekaert decided to connect two different technologies: steel wires and weaving. It is applied in all the main industrial fields: cement plants, steel works, power stations, harbours (i.e. shiploaders) and mining (i.e. primary crushers). To obtain this success, Bekaert cooperates with rubber belt producers including Italy's SIG SpA. Both companies share a common goal: to increase customer productivity and to reduce operating costs by offering premium value with innovative products.

Siderflex® belts are often compared to traditional steel cord belts (TST belts); however, from an economic and performance point of view, the origin and quality of competing products are not always as well known.

An alternative approach to steel cord belts

TST belt technology has now been consolidated and the running for the widest, the fastest, the longest and the strongest belts – such as the ST10000, which is under development – is still underway. However, since their inception, a certain weak point has not been solved. The presence of foreign objects in the bulk mass is statistically predictable: these can easily penetrate the belt and literally tear it into two parts, even along wide sections. Furthermore, the high longitudinal stiffness of steel cords cannot easily bear high energy impacts caused by handled material falling onto the belt at the loading point. For very long belts, cord stiffness is necessary and the high cycle time means the impact problem is not significant. Despite these issues, the selection of generic steel cord belts for any kind of application is common practice, even when other technology might provide a more suitable solution.

Siderflex® belts offer customised solutions and protection against impacts and cuts for very long belts, but also for extremely hard-duty applications.

Figure 1. Siderflex® fabric-like steel core.

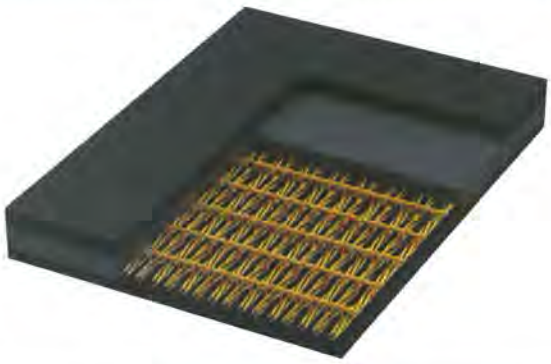
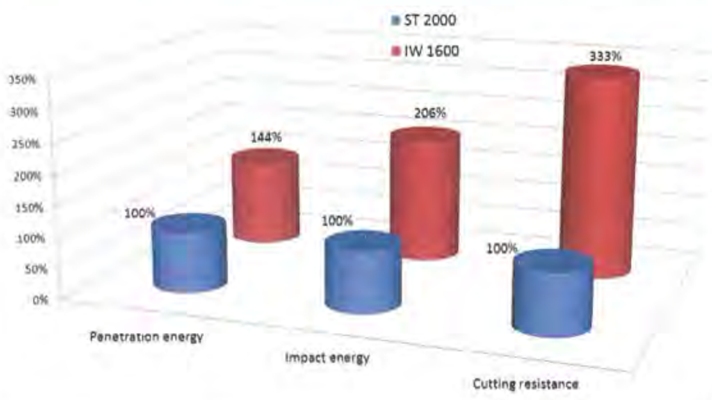


Figure 2. Impact and cutting comparison between Siderflex® and traditional ST belts.



Active protection against accidental cuts

Unlike TST belts, where simple steel cables placed along the main belt axis make up a mono-dimensional resistant element, Fleximat® steel fabric offers an active and bi-dimensional form of protection, which opposes the penetration of foreign objects. The difference in performance can be seen in Figure 2, which compares the IW1600 and ST 2000. A steel bar or a steel sheet, a pick or an excavator tooth falling onto a TST belt would penetrate an elastic and soft body, such as the rubber embedding the longitudinal cables, thereby cutting wide portions along the same belt. In contrast, as far as Siderflex® belts are concerned, the same object would impact against the protective layer of transversal steel cables and, consequently, it would be rejected, only causing localised damage to the belt. In extreme cases, TST belts may be completely cut into two parts, often without a warning to signal that the accident has occurred. With Siderflex® belts, however, the energy that is necessary to break the steel protection would induce the thermal protection to stop belt motion, thus saving the majority of the belt.

Sophisticated technologies for the protection of TST belts have existed for a long time: several antennas are placed in the belt cover at regular intervals and checked by suitable sensors to detect their breakage, in case an external object penetrates the belt. Notwithstanding the cost of installation, this system is theoretically effective; however, the experience of maintenance managers highlights a deep fragility: these antennas can break easily due to wear, fatigue and/or small accidents. The risk of big belt breakages due to the switching-off of the protection system is often a reality. A contradiction affects this system: the antennas must be broken to save the protected object from breakages but, when broken, they cannot protect anything from further breakages. It can be compared to a dozen electrical fuses in series which, when broken, require money and several hours for their substitution, when a switch allows them to be bypassed. The Siderflex® belt protects itself without the need for delicate and expensive external devices.

Figure 3. Constructive differences between Siderflex® and traditional ST belts.

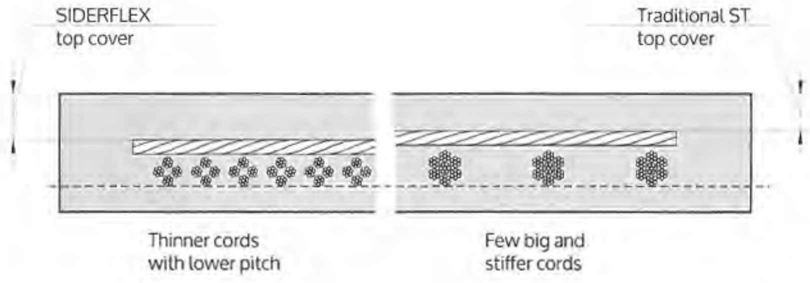
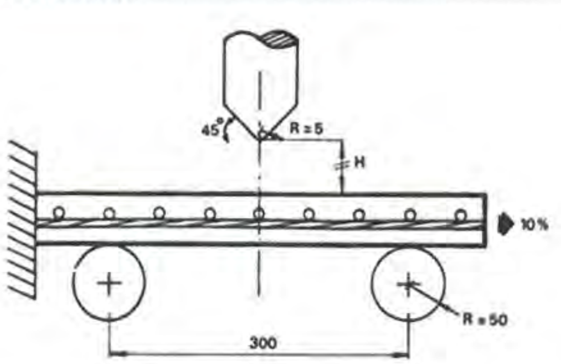


Figure 4. Bekaert 'weight drop method' for impact resistance test.



TST belts can also be protected by means of suitable nylon or steel breakers, which leads to results that are comparable with Siderflex® belts. However, as is shown in Figure 3, the top cover thickness – proportional to the belt lifetime – is thinner, even if the total thickness is unchanged. Figure 3 also demonstrates another characteristic aspect of Siderflex® belts: the Fleximat® steel carcass is generally thinner than the steel cord layer in TST constructions due to the use of cables with a reduced diameter. A thicker top cover means that the total belt thickness does not vary, leading to further advantages in terms of belt lifetime.

It is important to point out that the transversal reinforcement offered by Fleximat® is due to the high elongation and flexibility of the special steel cables. They were specifically conceived to protect the carcass below, remaining substantially 'invisible' in terms of transversal flexibility. These cables are composed of very thin filaments twisted in different yarns with reduced lay, giving the cable its high flexibility and dedicated elongation, which is much higher than traditional cables.

Figure 3 shows how Fleximat® fabric is characterised by a straight warp weaving where all steel cables – in particular the longitudinal ones – are perfectly straight, not weaved together and placed in separate layers. This particular construction does not allow for any transfer of strength between warp and weft cables, thus preventing any dangerous friction from occurring in the cables. Only a series of very thin and elastic nylon cords binds the cables, maintaining a stable fabric construction that is suitable for the calendering process, the manufacturing process where rubber is applied on the steel carcass (Figure 1).

Elasticity as improved impact protection

TST belts are made of 7x7 type cables (seven different yarns strictly connected together, each of which is composed of seven filaments), which are extremely thick and rigid. This is often a must, particularly where very long centre distances require the shortest elongations possible. However, other common applications exist – with typical centre distances between 50 and 2000 m – where elongation is not the main restriction and this priority is represented by the applications' ability to bear high energy impacts caused by the handled material. Usually, the shorter the belt, the greater the impact problem due to the short cycle time; furthermore, engineering choices suggest the realisation of very short belts, named 'sacrificials', for example under primary crushers where material size is large and often out of control. In these cases, the TST construction is not the right solution. Indeed, higher rigidity comes with lower impact and cutting resistance. In the wide range of Siderflex® belts, special constructions with a high elongation Fleximat® carcass are present; they are manufactured with open 4x7 type cables (four separate yarns, seven filaments each), which were specifically engineered to optimise the elastic response to impacts thanks to the presence of rubber in their internal structure. Although no standards exist relating to impact resistance measurement, Figure 4 highlights the Bekaert 'weight drop method' being used to verify this property in a reproducible way. A cone-shaped weight is dropped onto a pre-tensioned longitudinal belt sample from a certain height, giving as a result the necessary energy to break the cables and penetrate the belt. Figure 2 clearly shows the differences in performances between a traditional ST2000 with 7x7 cables, approximately 6 mm in diameter, and a Siderflex® IW1600 with 4x7 cables, approximately 4 mm in diameter. As predicted, the difference in energy needed to break the cables and to completely penetrate the belt core indicates that the more elastic belt is preferable.

Moreover, the high elasticity of transversal cables is a fundamental requirement to obtain the 'invisibility' properties described above. Therefore, the use of traditional cables cannot maintain the same transversal flexibility of TST belts – where only rubber is present between the same cables – and, at the same time, the impact resistance, which is typical of Siderflex® belts, cannot be reached.

Elasticity as versatility of use

The open cable structure of Siderflex® belts places these products half way between textile and TST belts: elasticity and elongations are typical features of steel products, without reaching the extreme values of 7x7 cables. This property allows Siderflex® belts to be installed in plants that were originally designed for textile belts, with no substantial modification in the structure. In contrast, this replacement operation is not possible with TST belts because their elastic modulus, which is 6 – 8 times higher, would require unacceptable modifications to the plant. Moreover, stability problems or premature deteriorations could happen if vertical curves are present in the layout. For similar reasons, Siderflex® belts can easily substitute TST belts, offering built-in cut protection, increased impact resistance, better adaptability to the plant, with elastic and permanent elongations that do not usually require correction to the take-up travel.

In many applications, a Siderflex® belt installation, instead of previous TST belts, has improved product lifetime: power stations, cement plants, iron works, mines and harbours demonstrate that Siderflex® can operate positively in every field of application. The most significant and recent examples are represented by the installation of a 7500 m belt in Egypt, a 15 000 m belt in Venezuela, a 15 000 m belt in Italy, a 6000 m belt in Algeria and a 7000 m belt in Congo, Zambia and South Africa in place of TST belts to handle limestone, coal, bauxite, iron and copper ore.

Customers all over the world and in different applications have recognised the premium value offered by Siderflex® over TST belts in terms of improved impact and cutting resistance. On top of that, Siderflex® comes with a thicker top cover, allowing greater wear resistance, which thereby increases belt lifetime. Obviously, this increases the operational efficiency and reduces the operating cost of material handling operations provided by the conveyor belt.

Siderflex® belts are manufactured in strict conformity with the specification of typologies C1 and C2 in the new International Standard ISO 15236. The same standard re-comprises the TST belts within typology A, which were previously defined by the Standard DIN 22131, now withdrawn. Constructions, test methods, denominations and joint procedures are clearly defined here in order to cover all possible applications. It is appropriate to highlight that Siderflex® belts of typology C2 fundamentally correspond to the TST belts that are defined in the above-mentioned DIN standard, with the inclusion of the Fleximat® reinforcement system described in this article.

Conclusion

Siderflex® conveyor belts are highly versatile products that allow for an improvement of handling plant performances and, in particular, an evident increase in the relevant lifetime. This is due to the presence of a particular resistant carcass in their core, which is named Fleximat®, where energy absorbing longitudinal cables are protected by one or more layers of transversal cables working as a barrier against foreign objects trying to penetrate the belt. As a consequence, impact and cut resistance are much higher than in traditional steel cord belts. This property helps to solve the vulnerability issues related to traditional steel cord belts, which are characterised by longitudinal cords embedded in the rubber, easily damaged by accidents. Furthermore, the particular cable construction means that Siderflex® can be applied in plants that were originally designed to use textile belts, ensuring the prevention of unforeseeable and untimely damage.