# A splice of the action

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*Amid a global economic downturn, cement producers need to do everything they can to improve operating efficiencies and reduce costs. At the heart of plant operations is the conveyor system – an excellent first checkpoint when seeking to optimise productivity. This article outlines what you need to know about mechanical splicing versus vulcanising to achieve higher cost savings through increased productivity.*

The join between two ends of a belt conveyor is a critical decision when deciding how best to maintain operating efficiency, belt life and costs

A critical area of importance on any conveyor system is the splice, and in most cement operations, there are two preferred types of splicing methods: *mechanical splicing*, the process of joining belt ends by metal hinges or plates, and *vulcanised splicing*, the process of joining belt ends through heat and/or chemicals.

Understanding the pros and cons of each splicing method is extremely important when making an educated decision on which splicing method to use. What are the environmental factors that might affect the splice? Are workers up against time constraints? What are the costs associated with long conveyor downtimes? These are just some of the questions to ask when choosing between mechanical fastening and vulcanisation.

## The vulcanisation process

Vulcanisation is an involved procedure that, if done correctly by an expert, can offer a smooth splice with minimal risk of snagging, tearing, and other harmful wear to the belt. There are several different types of vulcanised splices, including stepped splices, finger splices and overlap splices, and two types of vulcanising processes, hot and cold. Each process requires unique tools and an intimate knowledge of the rubber bonding process.

For both hot and cold vulcanisation, the belt must be disassembled and each belt end properly prepared according to that particular belt's splicing recommendation. Belt preparation is crucial to ensure that the finished splice will hold and perform to its published tensile ratings.

With hot vulcanisation, splices are heated and cured under pressure with a vulcanising press. This process takes a minimum of eight hours. If a belt is retensioned and used before the splice is bonded and completely cooled, the splice will be ineffective and may come apart completely, causing additional downtime.

Cold vulcanisation does not employ a vulcanising press, but rather uses a bonding agent that causes a chemical reaction to splice the two belt ends together.

When vulcanising, several factors must

be taken into account to ensure a high-quality splice. First, a vulcanised splice must be performed by an expert who is skilled and trained for the procedure and who has a thorough knowledge of solvents, bonding materials, and other cover and fill materials.

Second, the process requires a specific temperature, compression and dwell time of the equipment, in addition to a virtually moisture-free work area.

Third, some types of belts may not allow for vulcanisation at all. If a belt is old, dirty or unevenly worn, vulcanisation is not a good option because it won't always cure evenly, which can result in a weaker splice.

The entire process for the vulcanised splicing of a 24in belt will take about 8-11h, depending on working conditions. Wider belts may take longer. And because vulcanisation often requires time for a specialised vulcanising crew and equipment to be brought on site, plant operations can be shutdown for half a day or more, resulting in costly downtimes.

Ultimately, vulcanisation may cost thousands of dollars per splice, considering material and labour – and that's before considering the cost of downtime required to make the splice.

To summarise, use vulcanisation as your splicing method when:

- a clean belt that's free of contaminating agents, such as oil, sand, and material fines, has to be cleaned
- the belt is compatible with the adhesives of choice
- you have a new belt or belt without excessive wear
- you have a trusted, certified vulcaniser to perform the procedure
- the work environment is at an optimal temperature and moisture level
- there is easy access to the area you need to splice and plenty of room to work
- there is enough downtime available in your operation to allow for a properly installed vulcanised splice.

## An alternative: mechanical fasteners

The speed and simplicity of mechanical splice installation represents major advantages over the vulcanisation process. Depending on belt width and thickness, most mechanical splices can be finished in less than one hour and are installed by your own on-site crew with portable, easy-to-use installation tools. In the event that an unexpected splice needs to be made, you won't have to wait for professional assistance. Mechanical splices can also be made in restrictive environments, with no special regard for space, temperature, moisture, or contaminants. Plus, mechanical belt fasteners can be an excellent alternative given current economic pressures and budget cuts.

With plants running their belts for longer periods of time, the investment in vulcanised materials and external labour may not be viable. Typically, assuming you have a two-man crew, labour and materials might run to US$2000 to vulcanise a belt versus around US$100 for a mechanical splice. Table 1 provides an overall price comparison of the two methods.

Mechanical splicing also offers reduced belt waste and visibility of splice condition – both of which can significantly reduce costs. Because vulcanised splices often require consumption from 8-10ft of belt length, conveyers may not have enough "take up" if more than one splice is necessary over time.

And, because a mechanical splice is visible, wear and deterioration is visibly apparent and can be taken care of prior to a complete belt failure. Vulcanised splices, in contrast, typically deteriorate from the inside out due to poor adhesion. The first sign of wear comes too late for any preventive measure, resulting in catastrophic failure and longer downtime.

## Mechanical splicing and cement applications

As with vulcanisation, there are several types of mechanical fasteners, each created for use with different belt widths, lengths, thicknesses, speeds, tensions, and cleaners. Identifying the correct fastener for your application is essential to ensuring maximum splice life and performance.

Mechanical fasteners are available in two types, hinged and solid plate, and with a variety of attachment methods including rivets, bolts, and staples.

For cement plant applications, bolt solid plate fasteners allow for the greatest versatility. Bolt solid plate fasteners uses bolts to compress the top and bottom plates distributing splice tension evenly across the entire width of each fastener plate. For added strength and pull-out resistance, specially-formed teeth penetrate deep into the belt carcass but

**Table 1: overall price comparison – vulcanisation vs mechanical splicing***

| | *Vulcanised* | | *Mechanical* | |
|---|---|---|---|---|
| Labour | 2 workers/8 hours/US$75 hour | US$1200.00 | 2 workers/1 hour/US$30 hour | US$60.00 |
| Small tools charge | 2% of overall price | US$40.90 | None | US$0.00 |
| Mileage | 60 miles/2 workers/US$0.585 mile | US$70.20 | None | US$0.00 |
| Per diem | US$25/day | US$50.00 | None | US$0.00 |
| Splicing materials | Splice kit | US$150.00 | Splice kit (28 bolt solid plate fasteners) | US$51.50 |
| Downtime | US$1000/hr x 8 hours | US$8000.00 | US$1000/hr x 1 hour | US$1000.00 |
| Vulcaniser | US$275/day | US$275 | None | US$0.00 |
| Winder | US$150/day | US$150 | None | US$0.00 |
| Unwinder | US$150/day | US$150 | None | US$0.00 |
| **Total 1** | **Materials and labour only** | **US$2086.10** | **Materials and labour only** | **US$111.51** |
| **Total 2** | **With downtime** | **US$10,086.10** | **With downtime** | **US$1111.50** |

** Estimates are based on a 42'' splice. Pricing information was collected from Chicago area vulcanisers and Flexco 2008 Product Guides*

without damaging the carcass fibres. Bolt solid plate fasteners use specially designed templates, punches and boring tools making it fast and easy to accurately punch holes into the belt. The installation can also be done on site using portable hand or power tools.

No matter what the belt condition, mechanical fasteners are a good choice for both new and older, worn belts. Bolt solid plate fasteners can be used on belts ranging from 3/16in-15/16in (5-24mm). Concerns about comparable vulcanised splice strength can also be dismissed; bolt solid plate fasteners have a long history of service on belts with mechanical fastener ratings of up to 620 PIW (105kN/m). Although the bolt solid plate fastener can be used for a conventional 90˚ splice, if smaller pulley diameters are present (up to 25 per cent smaller size than recommended for 90˚ splices) these fasteners will allow for a 45˚ splice to accommodate smaller pulleys.

In addition, bolt solid plate fasteners also provide several installation benefits in cement plant applications. Twin mounting bolts, built into each bottom plate simplifies handling and positioning beneath the belt for faster installation. A piloted bolt can also help speed up installation because the piloted bolt tip cradles the nut securely in place, and simplifies installation by automatically aligning the bolt and nut threads.

Using a mechanical belt fastener is a great way to get more belt availability and reduced maintenance shifts. Mechanical fasteners are installed quickly and easily, on-site, with your own maintenance crews, usually in less than 60 minutes. The mechanical splice installation tools are easily transported to the job site and offer splice installers versatility in installation methods. Depending on the plant's available power source, mechanically attached bolt solid plate splices can be installed with as little as a basic installation tool and hammer, or with a modified electric installation tool. Vulcanising a splice typically takes eight hours or more whereas a mechanical splice typically takes an hour. Some might ask if their operation can afford the seven extra hours in downtime it would take to vulcanise.

Mechanical fasteners can also be countersunk, by skiving the belt during the installation process so that the fastener plates are flush with the belt's cover, which eliminates interference with tight-fitting scrapers, skirtboards, and other conveyor components. Countersinking also strengthens the fastener-to-belt attachment by positioning the plates closer to the belt's load-bearing carcass fibres. The belt strength remains intact as only a portion of the top cover material is removed. The belt's vital carcass fabric is left intact.

Besides virtually eliminating fastener rip-outs, bolt solid plate splicing cuts downtime by giving maintenance crews more freedom in deciding when to replace a splice. Any splice damage or wear and tear is very visible on a mechanical splice and operators can finish a shift even with a few plates missing and not worry about belt failure.

## Vulcanisation versus mechanical fastening: common misconceptions

Every splicing method has its limitations and it is essential to get the facts before deciding how to splice a belt.

**1. Mechanical fasteners can't be used with higher tension belts**

Synthetic carcass belts and improved fastener designs have resulted in mechanical fasteners that are compatible with belt tension ratings of up to 620 PIW

**2. With mechanical fasteners, sift-through of carried materials is a problem**

To prevent leakage and sift-through, vulcanised belts are ideal. However, when all things are considered, mechanical fastening may be preferable. If the splice is done properly, sift-through should not present a problem. Solid-plate splices can be sift-proof, and if filler tape is used with a bolt solid plate fastener sifting is eliminated.

**3. Mechanical fasteners are noisy, incompatible with belt cleaners and scrapers, and generally damage the belt**

If mechanical splices are properly installed, maintained, and countersunk by skiving the belt, there should be no problem with noise or damage to the belt or cleaner.

**4. All belts can be vulcanised**

Old and/or worn fabric belts are not well-suited for vulcanisation because the belt layers are weaker and will become brittle when heat is applied. Older rubber belts are also poor candidates for vulcanising, as the bondable properties of rubber deteriorate over time. Finally, vulcanising requires additional belt length, so operations with little take-up simply may not have enough belt to vulcanise.

**5. You can vulcanise any time, anywhere**

Only clean, dry, and relatively warm conditions are suitable for vulcanising. Chemical residue, excessive moisture and extreme temperatures can interfere with the curing of the adhesives and cause nicks and/or bubbles. These conditions, in turn, weaken the strength of the splice. In addition, vulcanising can be extremely difficult in areas that aren't easily accessible.

**6. Vulcanisation doesn't mean a lot of downtime**

In fact, vulcanisation requires you to shut down your belt for a substantial amount of time – much longer than a mechanical splice would. Not only do the chemicals take several hours to cure, but with a vulcanised splice, you're also at the mercy of your vulcaniser's schedule. A minimum of eight hours.

**7. Vulcanisation doesn't compromise belt strength**

Vulcanising actually robs your belt of an entire ply of strength – even more if not done properly. Mechanical fastening on the other hand, will not compromise the belt's integrity.

**8. Vulcanised splice inspection is easy**

The early signs of adhesion breakdown in a vulcanised splice are nearly invisible to the naked eye. Often, operators aren't even aware that a vulcanised splice is experiencing problems until it fails – a catastrophic event that requires the immediate shutdown of the line.

Conveyor belt and belt splice damage will always be a fact of life in most material-handling applications. Consequently, operations and maintenance personnel should have a thorough understanding of the available splicing and repair alternatives and how each method can affect the productivity and cost effectiveness of their operations.

New designs, materials, and processes are making mechanical splicing better than ever and incorporating mechanical belt fasteners into your splicing routine can provide numerous benefits for your output and bottom line. In most applications, including cement operations, mechanical splices offer the flexibility, economy and speed to keep material and labour costs down and avoid expensive downtime situations.