

Improve Operating Efficiencies in Material Prep with Continuous Splice Width Measurement

Erik O'Neil, Bytewise Measurement Systems

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Introduction

Today, tire manufacturing companies continue to focus on improving operating efficiencies to gain or extend competitive advantage by minimizing process variation and improving finished product quality. Bytewise Measurement Systems has contributed to the success of world-wide tire manufacturers in accomplishing both of these objectives. Many tire makers have experienced significant savings through the implementation of extremely precise Bytewise product and process measurement solutions from component extrusion through finished tire sidewall inspection.

Bytewise is now extending the opportunity for tire manufacturers to further improve operating efficiency in the material preparation area. Utilizing precise, non-contact laser triangulation technology, the in-line Bytewise Splice Width Monitor provides real-time product and process quality feedback for both automatic and manual calendered fabric bias cutting/splicing operations without effecting process cycle time.

After six months of operation, the initial installation of the Bytewise Splice Width Monitor is yielding impressive results. All overlap splices, including open splices, are accurately identified providing valuable process control and product trend data resulting in vastly improved quality of fabric ply material delivered to the tire building room. Based on this strong initial performance, many tire manufacturers world-wide are considering the implementation of Bytewise technology to improve operating efficiencies in the material prep area.

Why Measure Fabric Ply Splices?

Overlap splices in calendered fabric body ply material have several important effects on finished tire quality: (1) Sidewall appearance (2) Sidewall structural integrity (3) Tire radial uniformity. Excessively large (wide) overlap splices in the fabric body ply material result in a local "strong" point in the tire sidewall that does not expand to the same degree as the rest of the sidewall when inflated. This condition produces a visually objectionable "dent" or "indentation" in the inflated tire sidewall profile.



Figure 1: Inflated Tire Sidewall with a “Dent”

A below-tolerance overlap splice width or an open splice in the body ply may result in a structural sidewall defect. A local “weak” point is created by the lack of fabric cords, which appears as a “bump” or “bulge” in the inflated tire sidewall. This condition is especially significant in single-ply tire constructions.



Figure 2: Inflated Tire Sidewall with a “Bulge”

The overlap splice width also has a significant effect on finished tire radial uniformity. Inconsistent fabric cord spacing around the circumference of the tire contributes to unacceptable radial run-out, which is often observed by the customer as a vehicle ride disturbance. Precise monitoring of the fabric body ply splice in the bias cutting process ensures improved material preparation efficiencies and results in reduced rates of finished tire scrap and downgrades.

Principle of Operation

The Byte-wise Splice Width Monitor provides continuous, real-time measurement of fabric component splice widths in the automatic or manual bias cutting/splicing process in the material preparation area. Precise, non-contact, laser triangulation sensors are positioned to allow the calendered fabric material to pass between two (2) laser sensors.

Laser measurement data is collected in digital format directly from the sensor head, which provides a distinct signal at the leading and trailing edge of a material splice. The lasers continuously monitor the thickness of the material detecting instances where the thickness exceeds a user-defined threshold for a specified duration. The splice width is defined as the length of the distinct change in material thickness that exceeds the threshold.

The system is offered with two (2) or three (3) pairs of laser sensors referred to as system “channels”. A typical three-channel installation measures the overlap splice at both ends and in the middle of the calendered material.

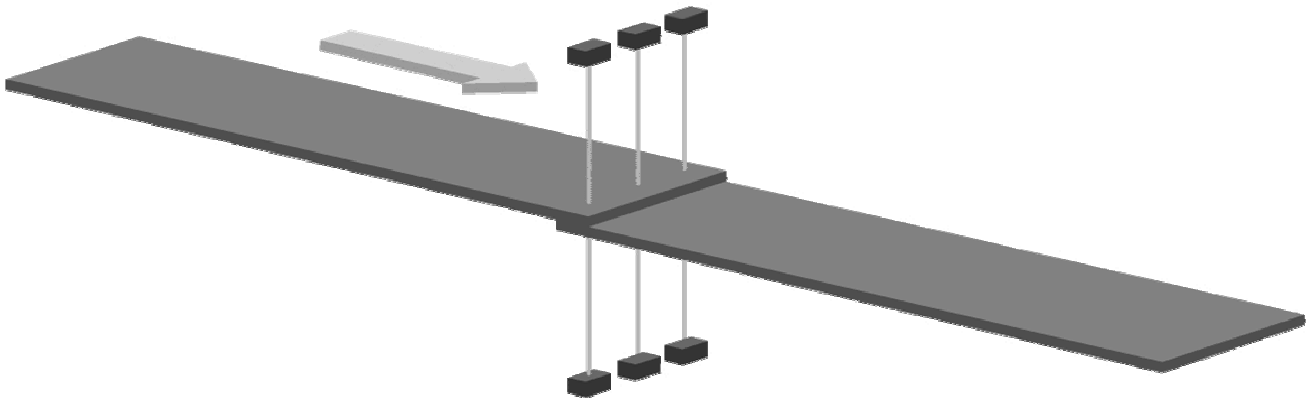


Figure 3: Bytewise 3-Channel In-Line Splice Width Monitor

Bytewise utilizes a dedicated controller running a commercially available real-time operating system, which is integrated with custom process control logic processing laser measurement data for each channel. Two of the three channels must register a detected splice or an alarm is generated. Alarms are also generated for gaps in the fabric (open splice) and excessive distance passed without a measured thickness exceeding the user-defined threshold (butted splice).

The dedicated controller operating the splice width monitor system is equipped with an Ethernet port that enables communication with Bytewise host software via TCP/IP. This architecture allows remote monitoring of the system, as well as easy access to process trend data from anywhere on the local or wide area network.

Laser Triangulation Sensor Technology

In an automatic splicing process, tire manufacturers have traditionally used contacting probes to measure overlap splice widths. Contacting probes often require that the fabric material stop or slow down in order to measure the overlap splice. This results in

additional cycle time and negatively effects operating efficiency. In a manual splicing process, overlap splice widths are often not measured at all.

The Bytewise Splice Width Monitor utilizes industry-proven Selcom SLS laser triangulation sensors that have been optimized to meet the demanding requirements of in-line process measurement. The high-speed Selcom lasers accurately measure overlap splice widths in an automatic or manual process without effecting process cycle time. In addition, the digital signal produced by the Selcom SLS sensor enables the detection of a distinct leading and trailing edge of an overlap splice. This feature produces much more repeatable splice width measurements relative to contacting probes that locate overlap splices based only on the material thickness deviation detected on the material surface in contact.

The Selcom laser triangulation sensors have been selected for this application due to their relative insensitivity to signal variations caused by drastic surface contrast changes. In addition, the Selcom sensors remain accurate and repeatable throughout the entire measurement range, which is important considering the ply material “flutter” that often occurs due to the constant starting and stopping motion during the automatic or manual cutting and splicing process.

Automatic & Manual Splicing Process

Incorporating in-line measurement in material preparation not only improves operating efficiency by providing real-time process feedback and/or control, but also ensures a higher quality product is delivered to downstream production processes. With the lack of a reliable measurement system in upstream processes such as bias cutting/splicing, tolerances must often be set to minimize the greatest risk in downstream processes.

For example, splice width tolerances are generally set to a large percentage on the high side of the actual target to minimize the occurrence of open splices that have the greatest risk of product defect downstream. Automatic splicers are set-up to avoid the narrow splice and operators are trained to err toward the wide splice in manual splicing operations. The result is often excessive splices that result in sidewall indentations and contribute to radial dis-uniformity in the finished tire.

In-line splice width measurement is capable of improving material preparation operating efficiencies in both automatic and manual splicing processes. In the automatic splicing process, Bytewise’s in-line laser splice width measurement provides real-time process trends and analog or digital signal outputs for automatic process control. In the manual splicing process, the same laser splice width measurement configuration provides the operator with real-time feedback and trends for making appropriate adjustments to his/her splicing techniques.

The pilot installation of the 3-channel Bytewise Splice Width Monitor has provided the opportunity to bring the automatic splicing process into control and deliver improved

The duration that the material exceeds the thickness threshold is displayed along the horizontal axis in inches or millimeters. The ability to view each splice profile is valuable in determining the consistency of the splice across the width of the material.

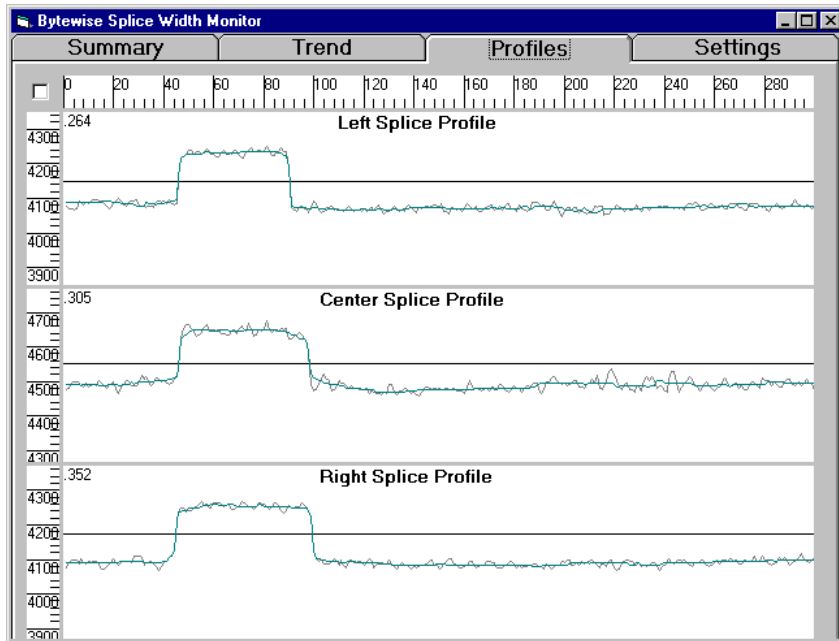


Figure 5: Splice Width Profiles

The main benefit of in-line splice width measurement is the ability to receive real-time process feedback for automatic process control or manual process correction. Figure 6 illustrates the splice width viewer display of splice width trends over time. The actual splice width for each channel and the average of all system channels is displayed relative to the overlap splice width target. Wide splices are shown above the target width line and narrow splices are shown below the target width line on the vertical axis. Splice width results move from left to right on the trend summary display with the most recent splice displayed on the extreme left.

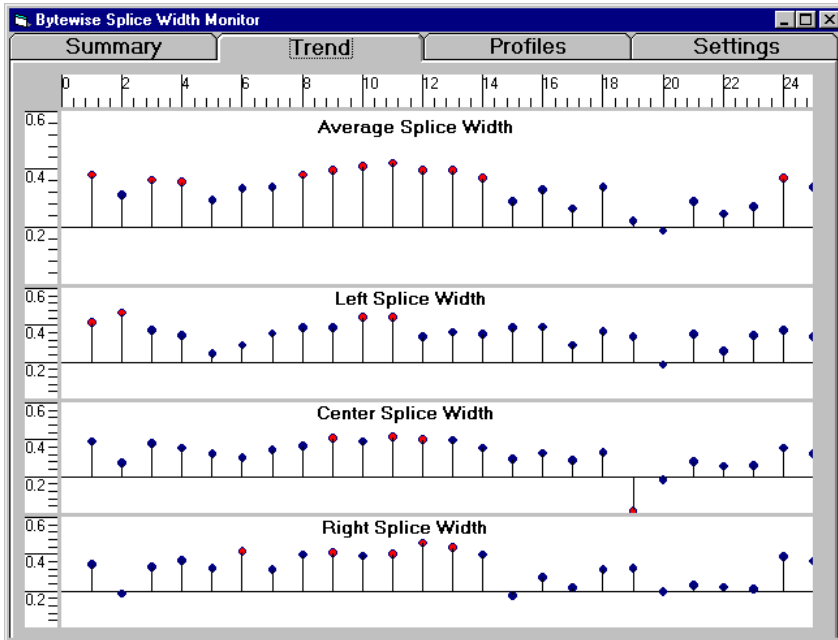


Figure 6: Splice Width Trends

Benefit Summary

The Bytewise Splice Width Monitor provides the opportunity for significant improvements in operating efficiencies in the material preparation area. Reliable in-line splice measurement enables automatic or manual process control and improves the quality of product delivered to downstream processes without effecting process cycle time. Finally, powerful software tools enable the capture of valuable process knowledge through real-time feedback and historical process trend data.