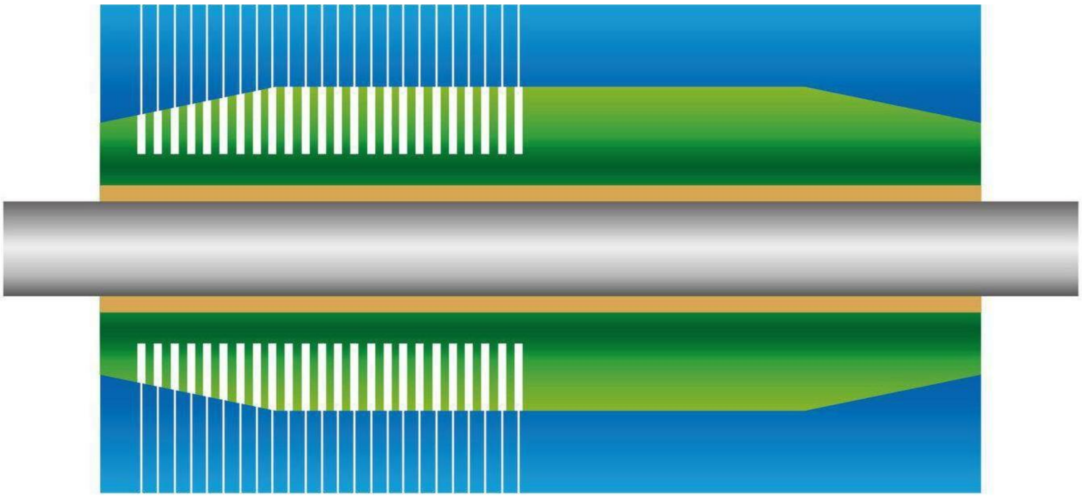


Structure of version 3.0 of the multilayer bonding roller – the paper weals can be embedded into the radial grooves / slots, thereby allowing the optimum contact pressure to be achieved.

New concepts for multilayer roller covers

As a solution in the high-speed flying splice method

In an offline coater, the web is made infinite with the help of a special adhesive tape using the so-called "flying splice". Here, the bonding process takes place in the millisecond range by pressing a rotating, rubberized roller onto the full paper roll. The paper tears even if a very minor disturbance occurs. The web edges are often obviously inadequately bonded. An increase of the pressing force, especially in the region of the edges, was required in order to create a higher line pressure there, as well as a sufficient line pressure in the center of the web. However, since the roller had to retain its cylindrical shape, a novel rubber-coated structure was developed. Significant improvements have already been achieved in practice.

The SM3 offline coater of Mitsubishi HiTec Paper Europe GmbH in Bielefeld (Germany) consists mainly of various processing stages for finishing the surface of the paper.

Between the unwinder and the reel, there is a dynamic coater, a curtain coater, the LAS roller dampener, three cylinder heater groups, 13 hot-air dryers, the soft-nip calender, and various function and guide rollers.

The base web is transported as a roll to the system and is to be refined in a continuous process into a function paper with a thermally sensitive layer. Therefore, it is necessary to bond the paper ends of the individual rolls together to make the web infinite. This process is called splicing; the he bonded piece of paper is called a splice (Figs. 1, 2).

Authors:
Christian Elsner, Mitsubishi HiTec Paper Europe GmbH, Bielefeld plant
Armando Giovannelli, Lüraflex GmbH; www.lueraflex.de

Process risks

This sensitive process has a very high risk of interrupting production
caused by web breaks because errors due to various boundary conditions can occur. The main boundary conditions are:

- inadequate bonding
  - positive substance jointing technique, in which the bonding strength of the adhesive tape must be matched to the absorption behavior of the paper web surface; constant functionality and quality of the adhesive tapes used
  - contact pressure and contact time of the force on the surfaces to be bonded
  - climatic conditions during the bonding process
- the roll winding quality: soft edges and non-cylindrical rollers are negative characteristics
- the technical reliability of the control unit for the bonding procedure
- the quality of the splice preparation
- the speed of the splice sequences, and thus the machine speed.

With increasing speed, the tear-off frequency during the splicing process also increases. Since the contact time of the force becomes shorter, poorer adhesion occurred, especially in the somewhat softer edge regions of the rolls. The resistance to the force exerted by the adhesive roller was lower, preventing good pressing of the adhesive onto the unwinding paper web.

Approaches towards solving the problem

In addition to optimizing the adhesive tapes with the help of the suppliers as well as improving the climatic conditions in the hall, especially in the area where unwinding occurs, a solution to improve the bonding in the area of the edges was sought. Base paper is produced in double-wide format (5.9 m) on paper machine 3. The width is then cut in half on a roll cutter and the paper edge is trimmed.

About Mitsubishi HiTec Paper Europe

Mitsubishi HiTec Paper Europe GmbH is a leading manufacturer of coated specialty paper approx. 470 employees at the Bielefeld location produce around 150,000 tons of noncarbon, thermal, label and inkjet paper per year in fully continuous production.

In the affiliated company in Flensburg, about 230 employees round out the product portfolio, producing 35,000 tons of high-quality thermal and inkjet papers.

Fig.1: Unwinding of SMS3, Mitsubishi HiTec Paper Europe GmbH, Mill Bielefeld

This results in a roll width of 2.9 m as an application width for the coater. Each coating machine application roll thus has a paper machine edge and a paper machine center. The web edge could not be made more rigid without additional disadvantages. Therefore, the adhesive roller was given a concave shape by taping with single-sided adhesive tape. Although a better contact pressure was achieved in the edge web to be bonded, the different speeds resulted in problems with moving the web to be bonded, the formation of wrinkles and opening of the splice prior to the actual bonding. A solution which allows a better contact pressure at the edges of the machines without causing a change in speed across the web width was sought.

Splice roll – theoretical approaches and setup

The first approach to the solution involved a rubberized adhesive roller with a sandwich structure. This was implemented with a central layer with a hardness of 35° Shore A (convexly ground) and an outer layer with a hardness of 70° Shore A, which was ground cylindrically after a two-step curing process.

This showed that the edges of the roller cover have a higher layer thickness of the hard material than in the center. As a result, a greater surface pressure is generated at the edges and a lower one in the middle. Thus, even though the bonding roller had a cylindrical shape, it was possible to produce different surface pressures (Fig. 3). The splicing adhesive tape was pressed more on the edges than at the center.

After numerous studies, the concept of a sandwich structure with a convex central structure appeared to be the most suitable for improving the existing situation. For Lüraflex, this was nothing new, since extensive experience in manufacturing and design has been gained in recent years in the field of multi-layer rubberization. With this method, the central structure can be designed exactly as required, in any form and function type, e.g. with cavities.

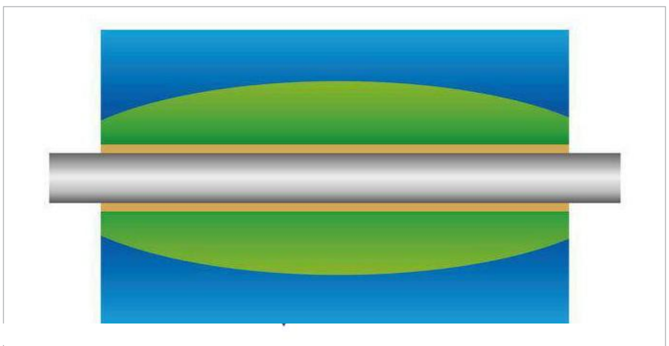


Fig. 3: Structure of the multilayer bonding roller, version 1

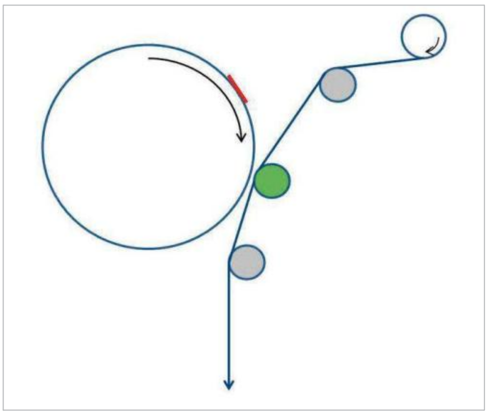


Fig. 2: Schematic diagram of SM3 unwinding

Here, the central structure is not completely cured. This leaves a certain amount of possible curing bonding areas open, so that the upper structure is fully bonded with the central structure in a second curing step.

Tests in the technical center

A variety of laboratory tests were performed on model rollers in the technical center (Fig. 4) concerning the nip form and the surface pressure in relation to the contact pressure. Using pressure-sensitive films, realistic pressure areas were tested and the development of the resulting nip width and surface pressure was determined.

In trial 1, it can be clearly seen that the surface pressure in the edge area is stronger than in the center of the roller. The discoloration of the pressure-sensitive film is proportional to the shape of the camber of the central structure. Likewise, the various contact pressure loads can be seen (Fig. 5).

Initial practical results

The practical implementation of the test results showed that this roller structure significantly improved the splice efficiency. A test phase that lasted approximately one year showed a 50% reduction of web breaks that are due to the splicing procedure.

The bonding in the region of the edge has demonstrably improved by the achieved uniform contact pressure, based on the new roller structure. Likewise, the effect of the harder upper material on the surface force could be seen. It was more difficult to pull apart the adhesive of the webs. This success was the starting point for further optimization efforts, because it was possible to further increase the production speed of the coating machine with a stable splicing procedure.

Fig. 4: Technical center facility

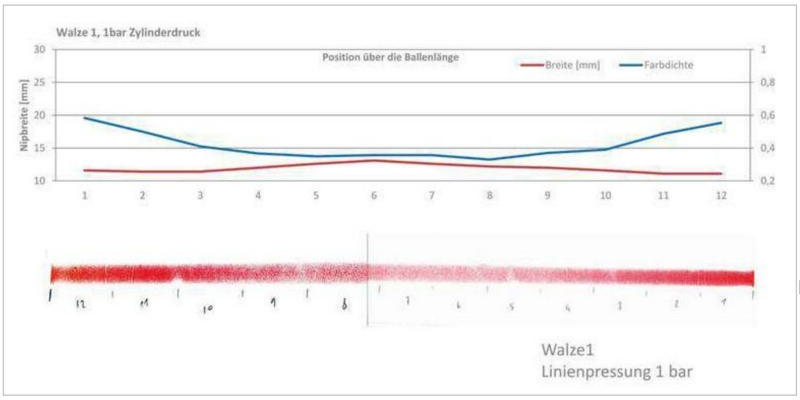


Fig. 5: Evaluation of the surface pressure and the Fuji Film impression, bonding roller version 1

The test phase showed that the contact force can be reduced when the adhesive roller is not yet completely settled in when it reaches the adhesive seam on the adhesive gap. This is due to the reduced time required for the bonding roller system to settle in (due to the increased speed of the coating machine) and to the oscillation of the rubberized adhesive roller when it impinges on the paper roll to which adhesive is to be applied. Hereinafter, this phenomenon will be called a “jumping roll” (Figs. 6, 7). This is an interaction between the paper roll characteristics, the pneumatically actuated adhesive roller lever and the rubberized roller surface that needed to be optimized.

Further optimization

Ink bleeding between the adhesive tape and the web required the further optimization of the cover. The detailed analysis revealed that especially very fine moisture weals were involved, caused by uneven pressing; these formed spontaneously due to storage and due to the high humidity in the area where unwinding occurred. At these points, the contact pressure immediately next to the moisture weal was not sufficient to produce a good bond. The unevenness was negatively influenced by the choice of the harder upper material. The reduced flexibility of the harder rubber produces a much higher contact pressure at the elevated points, but almost no contact pressure next to the elevated points. This results in substantially poorer bonding in the region of a moisture weal. These locations of poor bonding cause the coating ink to be pressed in on the blade coater, so that the splice is thoroughly moistened and weakened (Fig. 8). This in turn increases the risk of tearing off. The hard coating had to be made more flexible, which was first tested in the laboratory.

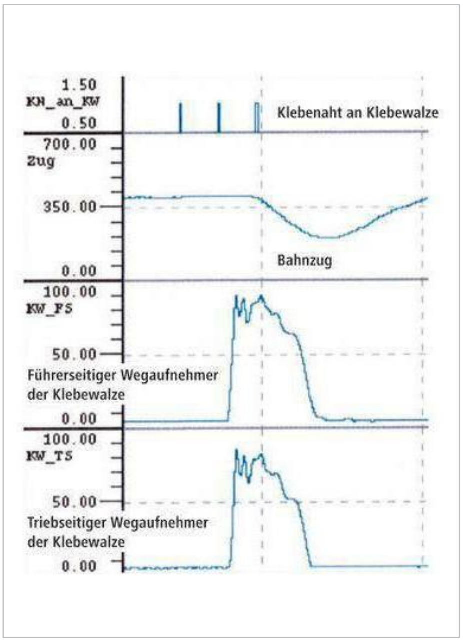


Fig. 6: Measurement of the splice procedure

New design for the splice roll

The “jumping” – or, to put it another way, the resilience – of the roller covering lies in the nature of rubber material, whose qualities differ from those of other materials. However, strongly damping rubber materials are not always suitable for manufacturing rollers. Furthermore, the problem of uneven abutment of the roller surface on the web to be bonded (moisture weals) must be solved. In order to find a solution for the problems described above, the following roller setup was tested. The rubber qualities and the basic design of the roller coating were retained. The inner camber, however, was replaced by a cylindrical central structure with strongly beveled edges. Radial grooves in the central section (i.e. the soft rubber) and radial slits in the upper structure (in the same location) were intended to provide significant damping of the rebound. The result of this design was to permit flexibilization of the hard rubber (cover picture).

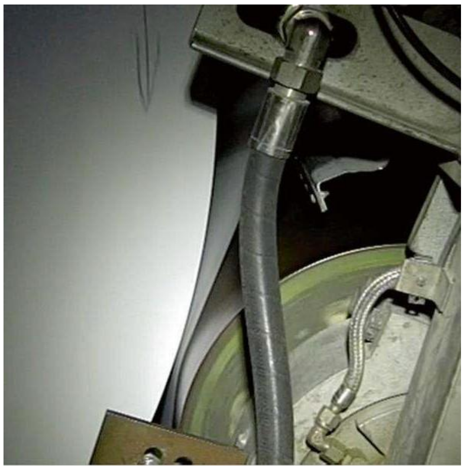
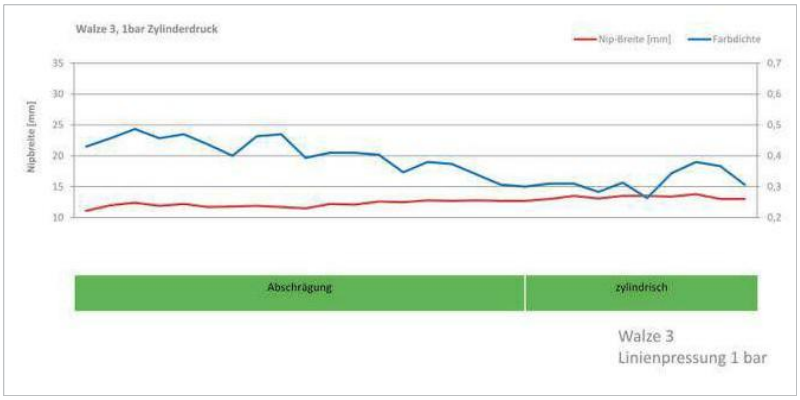


Fig. 7: Bonding roller shortly before the splice procedure

Fig. 8: Adhesive tape with Ink bleending

Fig. 9: Evaluation of the surface pressure and Fuji Film impression, bonding roller, version 3.0



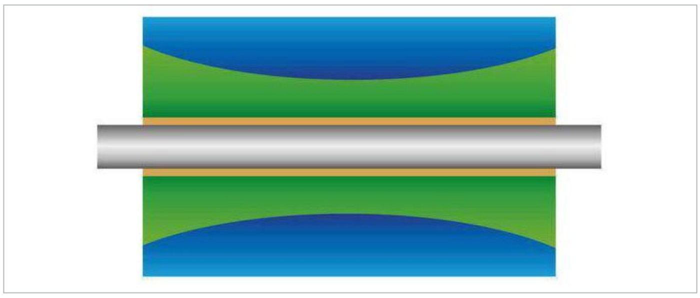


Fig. 10: Structure of a multilayer roller

Tests in the technical center

The laboratory tests showed significant improvement here. Furthermore, the model of the roller tested in the laboratory led us to expect optimization. The edge of the roller was reconstructed at a scale of 1:1 and examined in the test facility (Fig. 9). The film impressions showed significantly higher surface pressure on the edge than in the center of the roller. Likewise, the nip width was somewhat more pronounced. With increasing pressure, the difference between the edge and the center of the roller decreased slightly.

About LÜRAFLEX

Since its founding in 1949, LÜRAFLEX has grown steadily with the requirements of its customers. At its location in Neuss, qualified employees produce high-quality rollers from different roller core materials with various elastomer covers in special geometries for many different industries.

The production and processing of paper is carried out using elastic-covered rollers. These are an integral part of the continuously running systems in the various stages of production.

High-quality LÜRAFLEX roller covers have been used successfully for decades under diverse, often very difficult working conditions.

The influences in the paper industry on rubber roller covers are very complex. High abrasion resistance, high elasticity, excellent shock absorption, optimum sheet release, and excellent dynamic properties with very good resilience are just a few characteristics that the rubber roller covers must comply with in their application.

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Real-world results

A roller with the described rubber composition was created for the production plant; the “bonding roller 3.0” is installed since August 14. The previous analyses have shown no change in behavior with respect to the jumping. Improvements are being pursued using measures that affect the machine structure; these will not to be discussed further in this article. It was possible to significantly reduce the bleeding of the coating color on the blade coater. The bonding roller fits better to non-cylindrical rollers. The adhesion of the edges has also been further improved; of course, all results to date have yet to be verified.

An addition side effect was seen: because of the slotted structure, cleaning of the roller is significantly simpler and therefore less time intensive.

New roller concepts

During the test series, various considerations cropped up that were not included in the approach for solving the SM3 problem: one was to have a concave inner camber instead of a convex one. A roller model with this structure was then built and tested. It was found in practice that the surface pressure in the center was much higher than at the edges and that the nip width was significantly affected, as expected (Fig. 10). Such a roller could drive out air to the sides of a coil and be used on a winding machine (paper machine, coating machine, rolling machine, calender or similar equipment).

A profiled roller surface could also improve driving out of the air and prevent floating of the layers, especially on very airtight webs or systems that work at high speed. Therefore, improved winding quality can lead to improved product quality.

This version provides another advantage in the case of a long but slender roller. Here, sagging of the roll is compensated with an outer camber. The camber is specified using certain parameters. If one of these parameters is changed, the camber is no longer valid. Furthermore, an irregular nip results from an outer cambered roller. The new system with an inner camber, but also a cylindrical outer contour, results in a continuous nip with different surface pressures. Various considerations exist for achieving production processes through application-related optimization of rollers and their functions.

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