A New Generation SSB Triple Layer Forming Fabric To Improve Paper Machine Runnability And Paper Characteristics

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ABSTRACT

The trend toward bigger, faster and more efficient paper machines has enforced to develop new kind of forming fabrics. Triple layer fabrics have been in the market already for more than twenty-five years. For many years they were made of two separate single layer fabrics which were combined together with a separate binding yarn. These solutions never got any major share among forming fabrics even though their principle idea was very good. One reason has been their binding between the layers. Small movement between the layers caused excess wear of binding yarns leading to layer separation in particular if a high filler amount was included in the furnish. Also, too tight binding yarns caused unevenness in paper side surface topography. A clear step forward took place when the binding yarns were given a function also as a fiber supporting yarn. New sheet support binding, SSB, triple layer forming fabrics were introduced in the market.

Introduction

Metso Fabrics has been among the first companies to make and develop new type of triple layer forming fabrics. Figure - 1 shows how first SSB fabric was delivered and also run as early as in 1998. Immediate results were positive and the demand became rather high in a short time period.

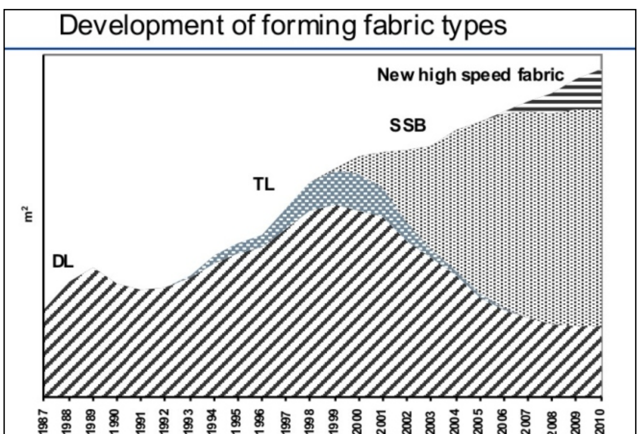

Figure - 1

Figure 1. Metso fabrics sales development with different designs

This presentation covers the advantages, the differences between different SSB fabric type and the improvements with latest types, Gapmaster fabrics more in detail.

Main reasons for SSB development

Figure - 2 shows how the surface of the fabric has become finer and the SSB fabrics have more fiber support points than double layer- or triple layer fabrics. This has an effect on marking, mechanical retention and printability properties.

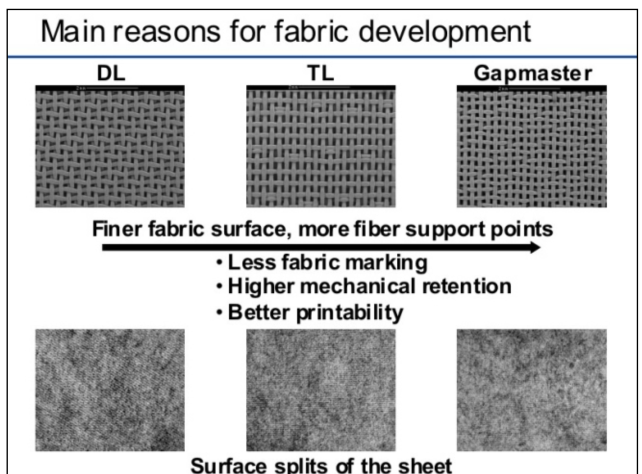

Figure - 2

Figure 2. Fabric surface vs. paper properties

Marking

One of the main driving forces in the development of SSB forming fabrics was to reduce fabric marking. Especially strong pressure came from a leading Central European SCA+ magazine paper producer to develop a 'marking free' SSB triple layer fabric. An SSB type fabric clearly shows the lowest marking compared to other types.

Retention

With much more fiber support points the SSB fabrics give better

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mechanical retention. Because of the improved retention papermakers have been able to reduce retention aid usage, which has given substantial savings in chemical costs.

Formation

The improvement in retention has led to an improvement in paper structure that has been seen as better formation in many cases.

Cross direction profiles

SSB fabrics have also given very good paper profiles, due to the good stability properties.

Experiments

All results with SSB-fabrics were not positive. The change that took place in paper structure also meant changes in drainage process. The following challenges to improve the runnability properties have been acknowledged:

- sheet dryness especially in formers with limited vacuum capacity
- some cases to reduce fiber and water carry

In the market there are designs that have tried to solve these problems by using very small diameter yarns and that way reducing the fabric caliper. This has led to reduced fabric stability that has been transferred to paper profiles. In addition to poorer profiles also sheet crushing cases where reported where evidently the loss in CMD stiffness has lead to excess yielding of the fabric under pressure. Unevenness in fabric profile has caused varying pressure in the slurry between the fabrics and enabled the sideways movement of the fiber and filler material in the slurry.

More important than the calliper, is the fabric's machine direction stiffness. SSB fabrics are typically very stiff and therefore their reactions to pressure impulses are weaker. High mechanical retention and weaker reactions of the fabric cause that the web carries more water to later dewatering elements. To optimise the fabric performance it is important to improve the fabric's reactivity during the formation process.

Development approach to improve SSB fabric runnability culminated in following target setting:

- reduced MD stiffness for better process performance.
- less fiber or water carry
  - → higher water removal capacity
  - → maintain stability to give good paper profiles
- maintain low marking tendency
- if possible reduce thickness without sacrificing stability

Of several different weave designs one showed immediately clear improvements and it was chosen to pilot trials first in HSRT simulator in Lappeenranta University and later in Metso pilot machines. We have also some brave customers who recognised the potential in the new style and we got a change to test the product in real environment.

How does the new SSB fabric differ from earlier structures?

Weave pattern

In Figure - 3, the new and the old structure have been compared. The photo of fabric's paper side surface shows how in conventional SSB structure the binding yarns make one row of supporting points.

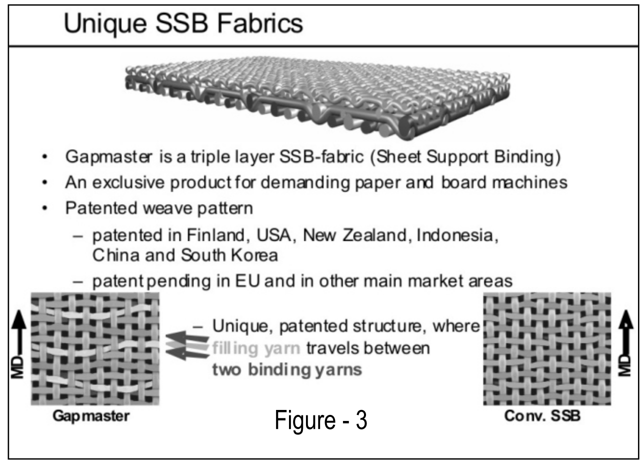

Figure 3. Metso fabric unique patented weave pattern

In the new structure the binding yarns have got a third 'member' into their group. This yarn is woven between the binding yarns on the paper side. The supporting points are now in two rows. An immediate improvement is that same fiber support is achieved with less paper side yarns.

New pattern also gives a possibility to increase bottom side CD yarn count keeping even distances between those yarns, Figure - 4. Unevenness that sometimes occurs in conventional SSB fabrics with dense bottom side leaves more drainage marking in the paper. Figure - 4 shows the change when same yarn diameters have been used. More yarns on the bottom side mean also more wear potential.

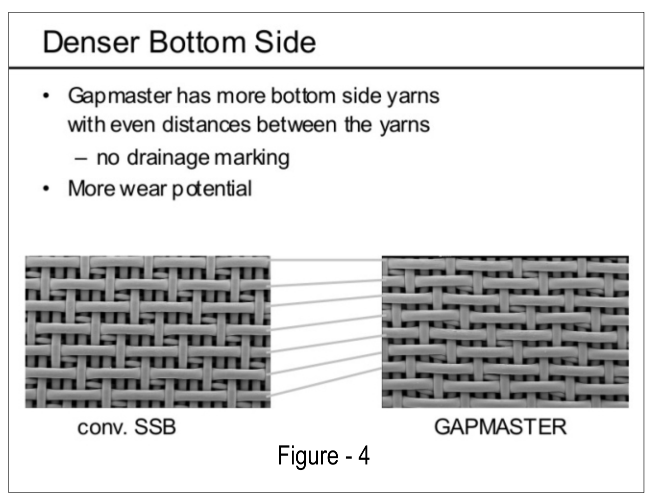

Figure 4. Difference of bottom side structure between conventional and new type of SSB desings

High fiber support

Usually as more yarns are added to the bottom side the permeability of the fabric goes down. To compensate it the yarn count on the top side must be reduced. A benefit in the new structure is that this loss is very small. The middle bars of the diagram in the Figure - 5. shows how small change in support point amount is when fabrics made of same yarns in same permeability are compared.

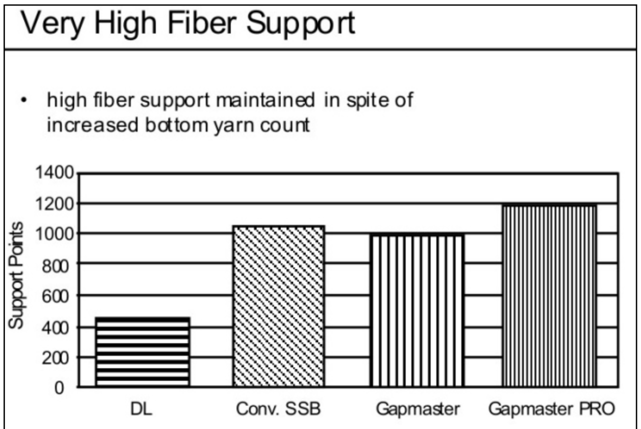

Figure - 5

Figure 5. Amount of the sheet support point between different SSB designs

Good runnability

Improvements are seen in the following three properties which are important for good runnability.

MD stiffness

The diagram in the Figure - 6 shows how the MD-flexibility has improved significantly.

It's believed that it is the flexibility that is the key property when it comes to how a forming fabric performs in the former. Low stiffness means that the fabric reacts quickly as there is suction in a forming shoe or as loadable blades force the fabric to change its course between the foils. The more and faster the fabric can react the more impact it has on the forming process and the sheet structure. On the other hand with a less reacting fabric the sheet will have denser layers near the fabric and more suction is needed for sufficient water removal. Dry content goes down. The delay in drainage brings more water to last stages where the dense sheet seals the fabric surface and removed water stays in the fabric instead of flowing to vacuum chamber. The MD flexibility is even more important with SSB fabrics because of the higher mechanical retention that they give.

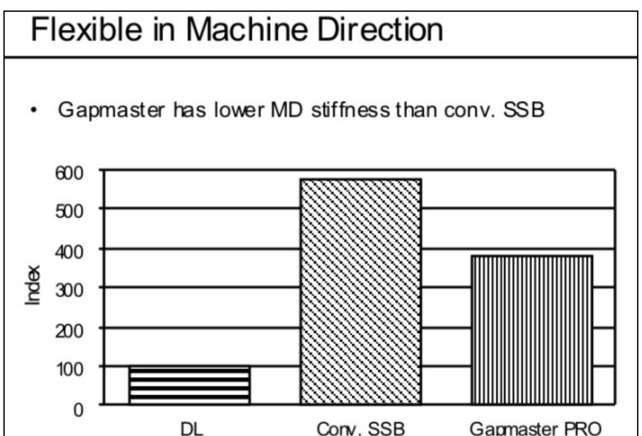

Figure - 6

Figure 6. Measured MD flexibility between different SSB designs

Diagonal stability

Already with double layer fabrics, DL, it was noticed how important it is for good paper profiles that a forming fabric has good diagonal stability. The elasticity of polyester and polyamide material requires that in a woven structure the monofilament yarns interlock well under tension.

Good interlocking improves the fabrics' running stability and has thus a direct impact on paper profiles. One reason for the good performance of double layer fabric has been their very good diagonal stability. It can be seen in the Figure - 7 that this property is now even improved with the new SSB weaving pattern.

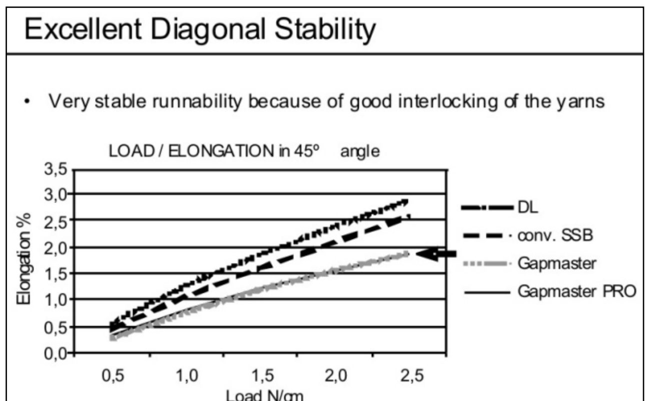

Figure - 7

Figure 7. Measured diagonal stability between different SSB designs

Thickness

The new type is more compact than conventional SSB. When same diameter yarns are used and the fabric is made to same permeability the thickness of the fabric is 0.04 to 0.06 mm lower and the fabric is more flexible in machine direction. Better diagonal stability gives also possibility to use a little smaller diameter yarns without risking the running stability and paper profiles. Thickness can be very critical e.g. in outer positions of some fast running gap formers.

Figure - 8 shows the differences in thickness of fine forming fabrics that have typically been used in SC and LWC machines. It also shows typical thickness range of double layer fabrics that are commonly used in different printing paper applications. The wear allowances are also shown.

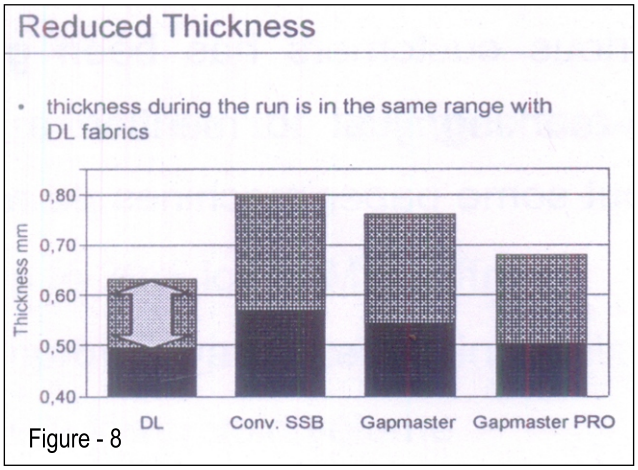

Figure 8. Measured thickness between different SSB designs

Results

Strong demand of new SSB fabrics

The growth has been very fast but it is expected that SSB fabrics usage will still expand while the amount of DL and TL fabrics will slowly decrease. For the growing demand Metso has developed different designs for different machines and different applications.

Gapmaster Product Family

Metso has four different designs at the moment, Figure - 9.

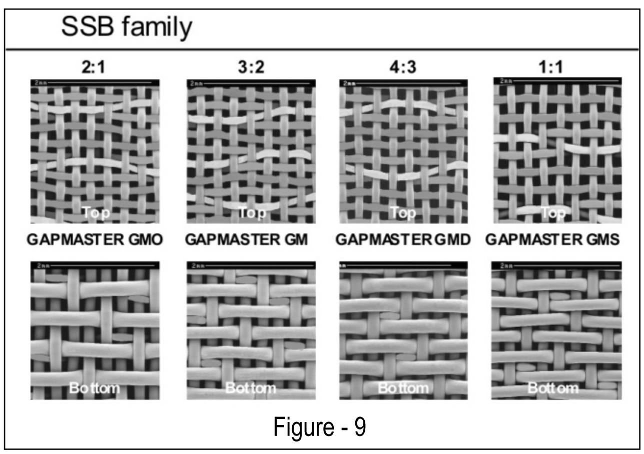

Figure 9. Different type of SSB structures

The most common structure

Most common SSB structure, Gapmaster GM (3/2-ratio) has shown its benefits in many demanding positions. Very fine surface combined with wear resistant bottom gives a nearly non-marking and stable fabric with a long running time. The feedback from various customers has been good runnability, high retention, clean running, excellent stability, no marking, just to mention a few benefits. GM structure is a very good product for many positions, but some paper machines do need different things and that's why the family has grown.

SSB fabric for wear prone positions

Gapmaster GM is already offering very good wear resistance, but especially fine paper machines using ground calcium carbonate were interested in a product with even higher wear potential. Metso's answer to them is Gapmaster GMD (4/3-ratio). This structure offers about the same wear margin, but the higher amount of bottom side CD yarns will give more wear potential (more material to wear).

In some cases Gapmaster GMD has even doubled the fabric life compared to conventional DL-fabrics. Other successes have been good profiles due to more stable fabric and lower retention aid usage due to better mechanical retention.

SSB fabric for improved retention

Especially fast running, on-machine coating paper machines, need a fabric that reduces the amount of pinholes in the sheet (lower paper porosity). Gapmaster GMO (2/1-ratio) offers a very fine top surface giving higher retention and denser sheet. On the other hand the coarse bottom layer has shown lower power consumption (less drag load), which has in some cases led to higher machine speed. Customers have been pleased with excellent retention and clean run of GMO fabrics.

Gapmaster GMS for high speed machines

Already today, and certainly in the future, the paper machines will run faster than ever. Those high speed machines need a fabric that will give high off-wire solids and clean run. Gapmaster GMS (1/1-ratio) has already given good results on fast running machines and many important trials will take place in the near future. On higher speeds the time for drainage will of course be shorter and the caliper of the fabric has got a very big influence on the final solids after wire section. Gapmaster GMS is nearly as thin as a standard double layer fabric, which has been very often the design for highest solids. In some trials same solids or even higher have been reached compared to DL.

Combined to high solids, the fast running machines need clean run in their formers. Gapmaster GMS has received very good feedback in that sense as well.

Conclusion

To summarise the changes between conventional and new type of SSB it has been noted the following:

- up to 30% lower MD stiffness
- improved yarn interlocking ability
- 10% lower void volume
- 0.0 – 40.06 mm thinner with same yarns
- 15 – 30% more yarns on the wear side
- same fiber support with 11% less paper side CMD yarns.

Also new type of SSB have maintained the good properties, high fiber support and fine drainage structure that gives high mechanical retention with practically no fabric marking. Fabric stability has even improved which should give better profiles in the paper web. They have better machine direction flexibility and with that faster reactions to pressure impulses. Better process performance should have a positive impact on formation. It increases drainage and gives also cleaner running.

When the properties of the new SSB structure are judged, it can be said that the development goals have been fully met.

References

1. Timo Pälä, Product Group Manager, Metso Fabrics Inc., PMC/Forming
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3. Hannu Martikainen, R&D Manager, Metso Fabrics Inc., PMC/Forming
4. Anne Paloheimo-Seppänen, Head of marketing, Metso Services