BladeCheck™ – Measurement of the Blade Contact-pressure Profile

Small thing – huge impact

Blades – Doctors – Scrapers – there are many names in the paper and board industry for a very widely-used, yet often little-noticed device.
Blade-like scrapers are applied to the rolls for cleaning in paper and/or board machines or in printing presses. The doctors have a blade which is usually at an angle of between 10° and 30° in relation to the tangent at the roll surface. Depending on the nature of the surface of the rollers and their rotational speeds, the blades consist of metal, plastic, ceramic, or composite materials. The contact pressure, designated in this context as the contact force per unit length of the blade, is normally between 80–400 N/m and is usually generated by compressed air, the weight of the blade, the blade holder and / or hydraulic devices.
The present article provides an overview of around 100 measured blade contact-pressure profiles at various points within a paper or board machine. Selected profiles are compared before and after optimisation. Possible problem areas and indication of frequent causes are obtained from discussion of the underlying problems and the resulting measurements.

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Fig. 1 shows the distribution of the measurements made in relation to the location of the measured blade. One can clearly recognise that nearly half of the measurements took place in the press section, and almost another 40 % in the dryer section. The remainder is distributed fairly evenly between the calender, the calender stack and the wire section.
The distribution of the measured blade across a variety of papers is shown in *Fig. 2*. Approximately one third accounts for corrugating medium and test-liner, 23–24 % for specialty papers and printing papers, 15 % for newsprint paper, 5 % for packaging paper, and 1 % for tissue. Since the optimal function of the creping blade is of major importance for tissue production, this small percentage is surprising. Apart from that, nothing unusual is evident in *Fig. 2*.
Looking at the problems shown by the measurements, in *Fig. 3* it is quite clear that "winder" or "passing" problems as well as issues of maintenance dominate the statistics with two-thirds of all problems. This is followed by issues related to breaks, deposits and energy savings. Only 4 % of the problems are due to blade life-time and parallelism.
The design of the patented BladeCheck™ measurement device is based on special segmented blades. The contact pressure of the blade is checked according to the patented BladeCheck™ methods by means of measuring blades, which are installed instead of cleaning blades. These measuring blades include strain gauges which are arranged at regular intervals parallel to the length of the roll and connected to a computer via cable.
The strain gauges are extended or compressed to a different extent by the deflection of the measuring blade – this depends on the contact pressure. The exact contact pressure can be determined by measurements of the electrical resistance after appropriate calibration. The strain gauges, which are arranged along the length of the measuring blade, allow direct measurement of the local contact pressure, the contact pressure in the area of the sections of the measuring blades, or the average contact

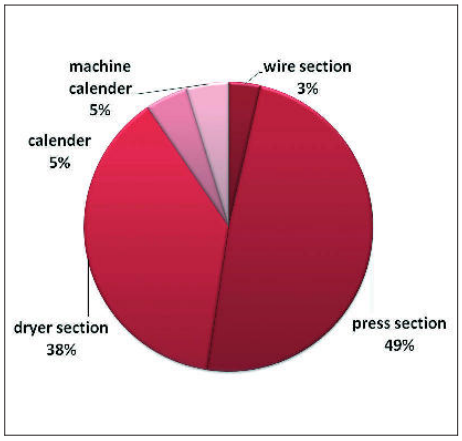

Fig. 1: Distribution across the location in the paper machine

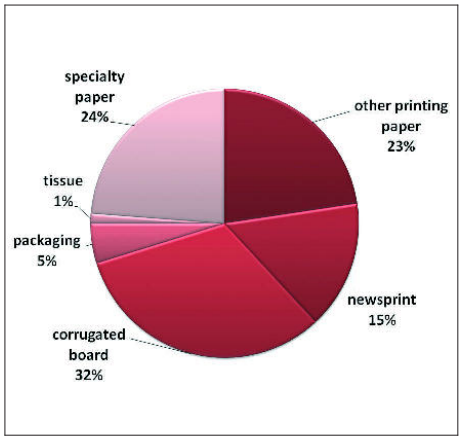

Fig. 2: Distribution of product groups

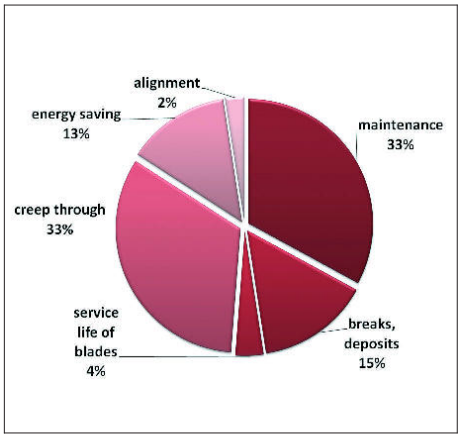

Fig. 3: Reasons for BladeCheck™ measurements

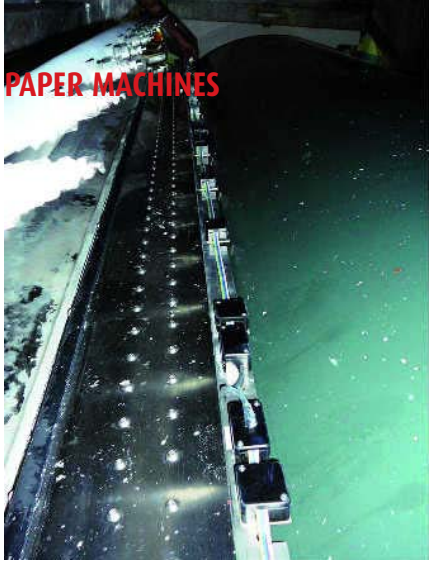

Fig. 4: View of a BladeCheck™ measuring device in action

Fig. 5: View of a "hidden" blade in a press section

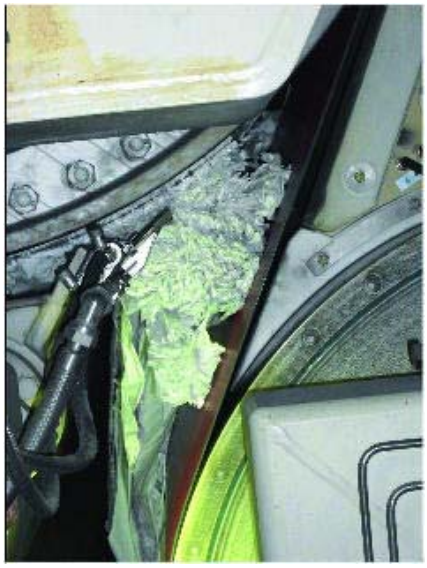

Fig: 6: Blade with a typical "winder" and/or "packer"

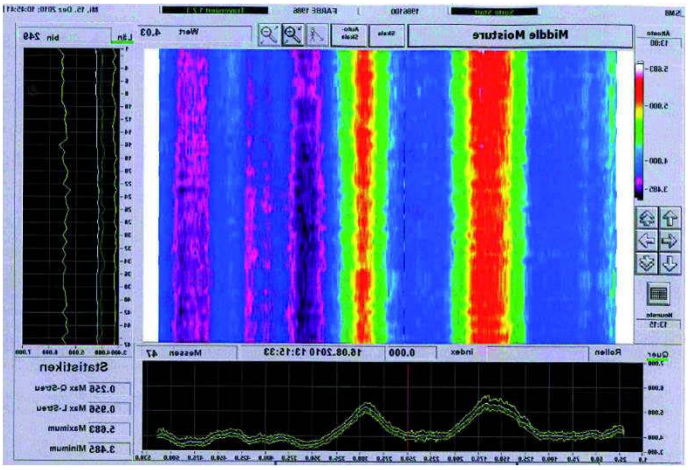

Fig. 7: Poor moisture cross-direction profile

pressure across the entire length of the roll. Depending on the results of the measurements, the pressure applied by the blade holder can be adjusted.

In *Fig. 4*, an installed BladeCheck™ measuring device, ready for data recording, can be seen. The little black boxes of the strain gauges with associated electronics and cabling are also visible. The roll to be measured is shown on the right side, in blue-green colour

Unfortunately, the installation locations of the blades in modern paper machines are almost impossible to reach in some positions. *Fig. 5* shows the beginning of a blade through the framing. It is pulled through this narrow opening for replacement. This is reminiscent of some modern cars which need the mudguards and the bumper dismantled simply to change the bulb of the parking light. At that point, one would gladly hand over the task to the respective designers and planners.

As most people have probably never seen a typical "winder" or "packer" on a blade, an example of this can be seen in *Fig. 6* below. In such situations, the paper build-up can be very fast, very hard, very thick, and bend under the blade. In the worst case, it can bend not only the blade holder, but also cause tremendous damage to the framing and clothing. We have even been called in on emergency situations where large paper machines had not been running for several days and severe damage had occurred.

Quite often little attention is paid to the impact of non-optimally working blades on energy consumption and the moisture profile. An example of a poor moisture cross-direction profile is shown in *Fig. 7*. Here, different colours mean different humidity levels at these locations. One can easily see the differences that occur in the form of narrow and sharp lines. Such moisture fluctuations may well result from defective blades or blade holders, because various contact pressures can lead to different thicknesses of the build-up of deposits on dryer cylinders. The thickness of the deposits directly affects the heat transfer at this point between the cylinder and the paper. This, results in a poorer drying performance, and in moisture fluctuations. In such cases, more energy is saved by measuring the blades in question than by balancing the moisture cross-direction profile by specific remoistening. In this case, expensive equipment is used to compensate a problem in a rather simple part of the machine.

In many cases, the emerging blade problem stems simply from inadequate cleaning of the blade holder or is due to an incorrect or inconsistent blade angle. In *Fig. 8* and *Fig. 9*, two examples can be seen of the condition of blades, as often found in paper machines. The dirt on the blade around the blade holder can be both inorganic (filler, dust) and organic (fibre residues, bio films). In combination with the prevailing moisture and elevated temperature, it can lead to very resistant impurities. When changing the blade this dirt can slip into the blade holder and result in significantly raised or lowered contact pressure. In addition, it can happen that the dirty blade holder is no longer able to create the same contact pressure at the tip of the blade when the same hydraulic pressure is applied, because the mechanics are heavily soiled.

Measuring the contact-pressure profile in the cross direction generally takes place at the normal production pressure level of the respective blade and at higher and lower contact pressure. A typical measurement curve; for a third press, can be seen in *Fig. 10*.

Fig. 8: Dirty blade

Fig. 9: Dirt on the blade, in detail

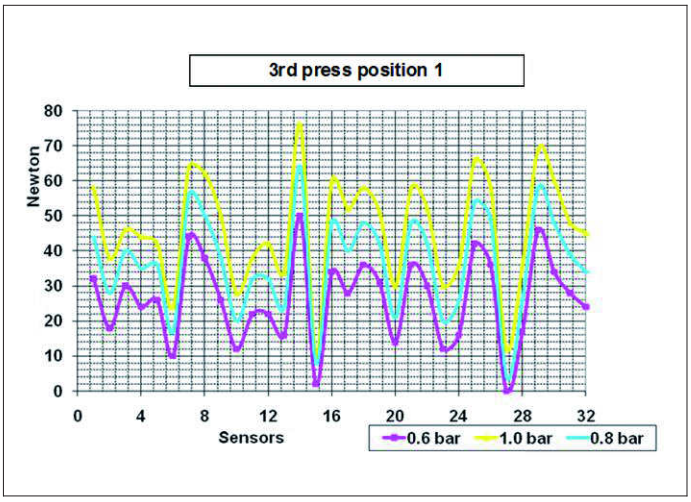

Fig. 10: Contact-pressure curves in the third press with different contact force [N]

It is easy to recognise that, in this case, sufficient contact pressure to avoid "packers" is not obtained in some places (Sensors no. 6, 15, 27) when a pressure of 1.0 bar is applied, even though this is 20 % higher than the usual pressure of 0.8 bar. This presents a serious hazard potential and the blade holder should be cleaned before other measures are taken. If the problem remains, changing the blade holder may be necessary. If individual press fingers were broken, repairs may be a possible solution. A similar curve for a drying cylinder is shown in *Fig. 11*. Here, the usual pressure was at 2.5 bar, and it is easy to recognise that this gives good results.

Fig. 11: Contact-pressure curves in the third press, with different contact forces [N]

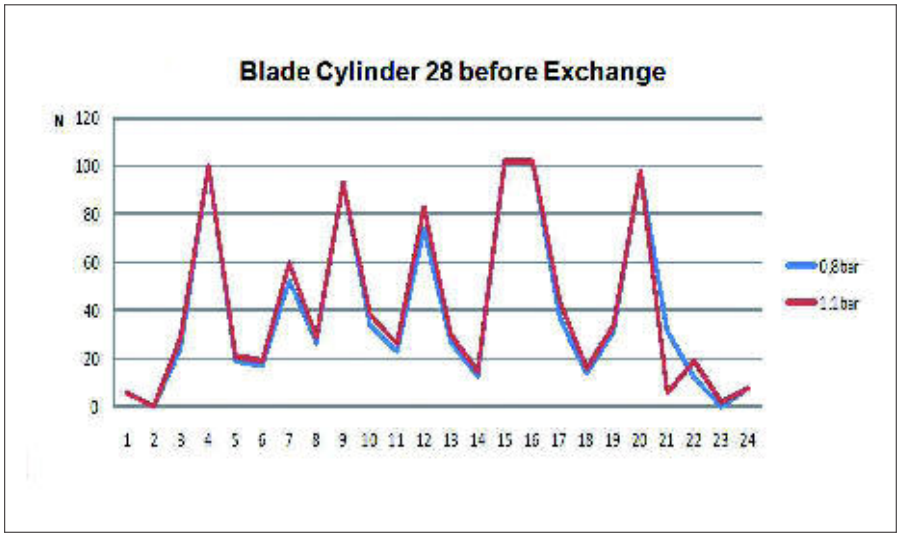

Fig. 12: Contact-pressure curves in the third press, with different contact forces [N]

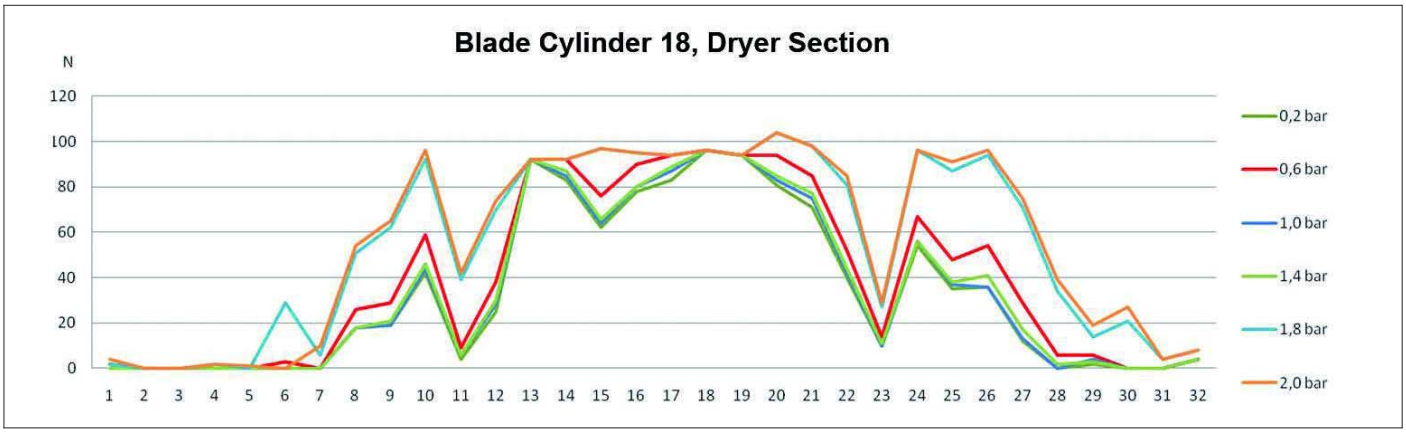

Fig. 13: Very poor contact-pressure profile

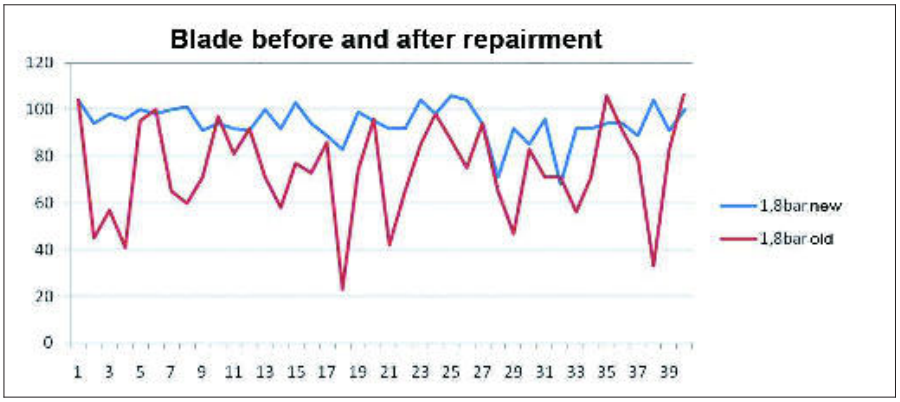

Fig. 14: Contact-pressure profile before (red) and after repairs (blue)

A reduction in contact pressure below 2.0 bar is not advisable in this case. A similar curve with a bad blade in a dryer section, as shown in *Fig. 12* below, illustrates how a change of air pressure / contact pressure does not lead to a change of the real contact pressure at the tip of the blade. There are also massive fluctuations in the contact-pressure cross-direction profile, which suggests that urgent measures need to be taken.

An example of a catastrophic cross-directional contact-pressure profile can be seen in *Fig. 13*. At the edges of the roll, virtually no pressure is applied to the tip of the blade – which inevitably results in problems with deposits and runability.

That measures to optimize blade systems are worthwhile and possible is illustrated in *Fig. 14*, which shows the contact-pressure profile of a blade on a central roll before repairs (red), and after repairs. After repairs the profile still has minor weaknesses in the area of sensors 28 and 32, but is clearly better than before repairs, and is good enough for normal operation of the paper machine.

An analogue improvement is given in *Fig. 15*. It is clearly shown that the contact pressure profile has been significantly improved by the repairs. Whether the problems result from the lowering mechanism of the blade holder can be determined by inspecting the total contact pressure at higher and lower air pressures. In *Fig. 16*, the pressure measurements for an irregularly-functioning blade holder are illustrated and, in *Fig. 17*, those for a problem-free functioning blade holder.

To summarize, it can be determined from over 100 BladeCheck™ measurements on different blades in various positions that really good cross-directional contact-pressure profiles are found in less than 10% of the cases. BladeCheck™ measurements can help to resolve the errors on the blades, sometimes immediately. This is, for example, the case when the (wrong) pressure was set only on the basis of the contact-pressure table of the blade holder manufacturer. The adjustment of the compressed air pressure is enough to achieve the desired contact pressure. In most cases, however, repairs or even

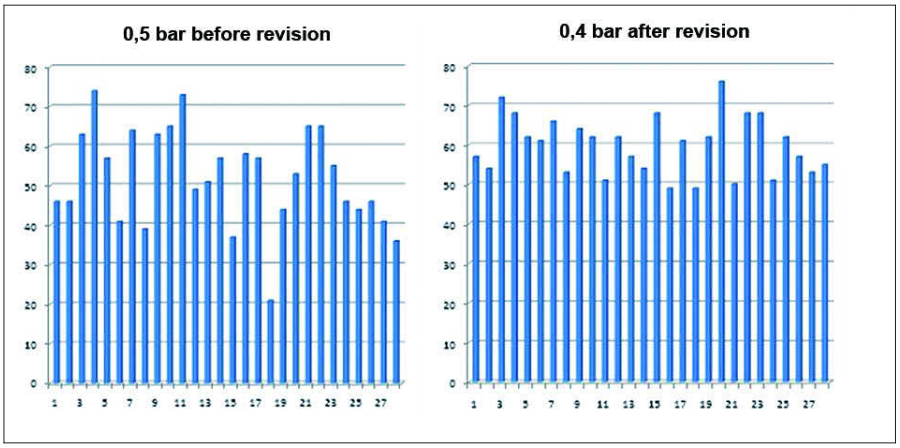

Fig. 15: Contact pressure-profile before (left) and after correction (right)

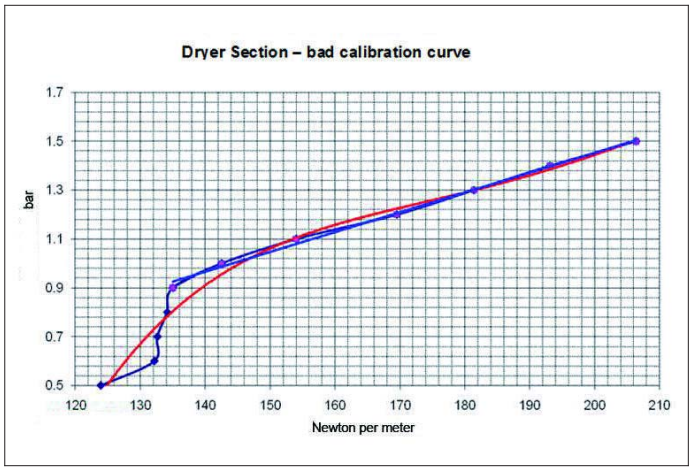

Fig. 16: Contact pressure diagram of an irregularly-functioning blade holder

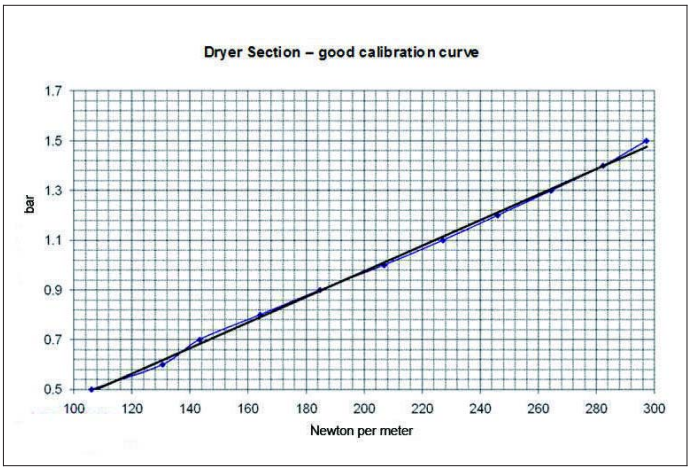

Fig. 17: Contact pressure history of a functioning blade holder

replacement of the entire blade holder are required. Here, it makes sense to repeat the measurement after repairs, in order to a) prove the success of the repairs and b) to have a comparison for possibly-occurring changes at a later date. As with medical diagnoses, one can recognise changes most easily if two conditions, ascertained at different times, can be compared.

Blade holders themselves are not very complicated systems and are rather inexpensive in comparison to the costs incurred by problems or accidents caused by poorly functioning blades.

The most common source of problems, in addition to the already-mentioned contamination, are:

- defective plate holder
- defective hose holder
- bent or broken press fingers
- lack of parallelism
- worn bearing clamps,
- defective oscillation
- defective pneumatics

A quick measurement can, within a few hours, help to prolong the life-time of the blade, improve the moisture cross-directional profile, reduce the number of "winders", and thus significantly improve the runnability of paper and board machines.