EXPERTIP

Category	DRYING
Keywords	Dryer fabric, Seam distortion, Misalignment, Dryer fabric tension, Concave rolls.

Bowing, Narrowing and Distortion

If all conditions on a paper machine were perfect, the dryer fabric seam would always run straight. In reality, this seldom happens. Analysis of the cause and effect of a seam bow is a key step to getting the most from a dryer fabric and the paper machine on which it turns.

Type of Seam Bows

Over the years, the paper industry has come up with a lot of different names for various types of seam bows. For the purpose of this discussion, however, they may be classified into two general types.

The symmetrical bow is shown in Figure 1. In this case, the front and back edges run about even and the center runs ahead. The amount of this type of bow is determined by the distance from the center of the seam to an imaginary line connecting the two edges.

A front-to-back misalignment bow is shown in Figure 2. In this type of bow, one edge leads the other. This distortion may take various shapes depending on the conditions in the dryer section. The amount of this type bow is determined by the distance one edge leads the other.

Effects on Seam Bows

Seam bows have a variety of effects on dryer fabric and paper machine performance, and most of these effects are undesirable.

The most notable results are:

1. Loss in fabric width is the inevitable result of any type of bow. A severe bow can cause so much width loss that the edge of the sheet will be unfelted which could result in premature fabric removal. Table 1 shows the amount of width loss for bowed fabrics. For example, a 6.1 meter (240 in) wide fabric with a 76 cm (30 in) long bow will lose 25 cm (9.9 in) of width. A rule of thumb is distortion of 6% of the fabric width or greater should be corrected.
2. Variation in fabric tension and drying are also caused by seam distortion of the fabric. The tension profile and amount of variation changes with the type and length of seam bow. A fabric with a symmetrical bow runs tight on the edges and relatively slack in the middle. This tension profile tends to add to overdrying of the sheet's edges and high moisture in the middle. Moreover, this condition places unduly high stress on the seam's edges, which carry most of the tension load of the entire fabric. If left uncorrected, a symmetrical seam bow can contribute to early seam failure at the fabric edge. A fabric with a front-to-back seam bow has lower tension on the edge that is running ahead. The greatest amount of stress is being applied to the edge of the seam that trails. A seam running with a front-to-back bow leads to uneven moisture profiles on the front and back edges of the sheet.
3. Variation in permeability is a characteristic of bowed fabrics. A distorted fabric will not pass air or water vapor at the same rate as an undistorted fabric. When woven, a dryer fabric is "square" and the openings in it are uniform in size, producing a fabric with uniform permeability. If this fabric is distorted as it runs on the machine, the openings change shape and may restrict the passage of air or water vapor. These variations in permeability can cause non-uniform drying and moisture profile problems.

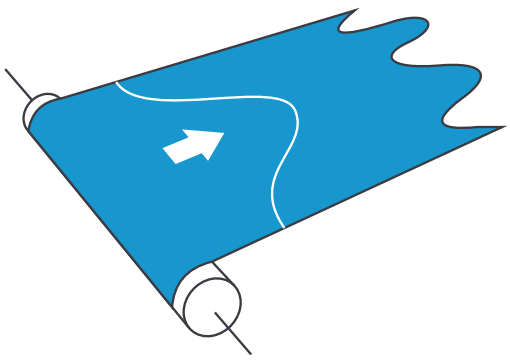

FIGURE 1.

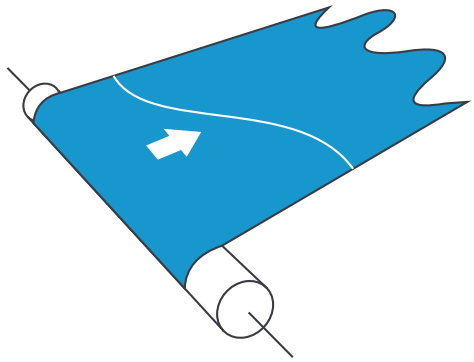

FIGURE 2.

Table 1: Width lost by Symmetrical Bowed Felts

Bow (cm)	203	305	406	508	610	711	813	914	1016
8	0.5	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.0
15	2.8	1.8	1.3	1.0	0.8	0.8	0.5	0.5	0.5
23	6.6	4.3	3.3	2.5	2.0	1.8	1.5	1.3	1.3
30	11.9	7.9	5.8	4.8	3.8	3.3	2.8	2.5	2.3
38	18.5	12.4	9.4	7.4	6.1	5.3	4.6	4.1	3.6
46	26.2	17.8	13.5	10.7	8.9	7.6	6.6	5.8	5.3
53	35.3	24.1	18.3	14.7	12.2	10.4	9.1	8.1	7.4
61	45.5	31.5	23.9	19.0	16.0	13.7	11.9	10.7	9.6
69	56.9	39.4	30.0	24.1	20.3	17.3	15.2	13.5	12.2
76		48.3	37.1	29.7	24.9	21.3	18.8	16.8	15.0
84		57.9	44.4	36.1	30.2	25.9	22.6	20.3	18.3
91		68.3	52.6	42.7	35.8	30.7	26.9	24.1	21.6
99		79.5	61.5	50.0	41.9	36.1	31.8	28.2	25.4
107		91.2	70.9	57.6	48.0	41.9	36.8	32.8	29.5
114		103.6	80.8	65.8	54.4	48.0	42.2	37.6	33.8
122		116.6	91.2	74.7	61.2	54.4	47.8	42.7	38.4
130			102.4	83.8	68.3	61.2	53.8	48.0	43.4
137			113.8	93.5	75.9	68.3	60.2	53.8	48.5
145			125.7	103.6	84.1	75.9	67.0	59.9	54.1
152			138.4	114.0		84.1	74.2	66.3	59.7
160							81.5	72.9	65.8
168							89.2	79.8	72.1
175							97.3	86.9	78.7
183							105.4	94.5	85.6

Bow (in.)	80.	120.	160.	200.	240.	280.	320.	360.	400.
3	0.2	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0
6	1.1	0.7	0.5	0.4	0.3	0.3	0.2	0.2	0.2
9	2.6	1.7	1.3	1.0	0.8	0.7	0.6	0.5	0.5
12	4.7	3.1	2.3	1.9	1.5	1.3	1.1	1.0	0.9
15	7.3	4.9	3.7	2.9	2.4	2.1	1.8	1.6	1.4
18	10.3	7.0	5.3	4.2	3.5	3.0	2.6	2.3	2.1
21	13.9	9.5	7.2	5.8	4.8	4.1	3.6	3.2	2.9
24	17.9	12.4	9.4	7.5	6.2	5.4	4.7	4.2	3.8
27	22.4	15.5	11.8	9.5	8.0	6.8	6.0	5.3	4.8
30		19.0	14.6	11.7	9.8	8.4	7.4	6.6	5.9
33		22.8	17.5	14.2	11.9	10.2	8.9	8.0	7.2
36		26.9	20.7	16.8	14.1	12.1	10.6	9.5	8.5
39		31.3	24.2	19.7	16.5	14.2	12.5	11.1	10.0
42		35.9	27.9	22.7	19.1	16.5	14.5	12.9	11.6
45		40.8	31.8	25.9	21.9	18.9	16.6	14.8	13.3
48		45.9	35.9	29.4	24.8	21.4	18.8	16.8	15.1
51			40.3	33.0	27.9	24.1	21.2	18.9	17.1
54			44.8	36.8	31.1	26.9	23.7	21.2	19.1
57			49.5	40.8	34.6	29.9	26.4	23.6	21.3
60			54.5	44.9	38.1	33.1	29.2	26.1	23.5
63							32.1	28.7	25.9
66							35.1	31.4	28.4
69							38.3	34.2	31.1
72							41.5	37.2	33.7

Causes of Seam Bows

Understanding the causes of seam bows is the key to deciding what corrective action is necessary.

Symmetrical bows are usually caused by roll deflection. The most common causes of roll deflection are excessive fabric tensions and/or old rolls that merely sag or deflect. The recommended tension for dryer fabric guiding is 1.05 to 1.40 kN/m (6 to 8 pli). Tensions above this level do not appreciably improve fabric guiding. In older dryer sections that are not designed to handle increased pli, issues occur such as seam failure due to extensive distortion, high fabric wear rate, increased likelihood of accidental damage, journal/bearing failure, and roll deflection. Roll diameter differences – due to buildup of stock, stickies, rust, or other foreign materials on the roll face – can also be a cause of a symmetrical bow.

Front-to-back misalignment bows result from rolls that are out of line and/or differences in roll diameter. All the rolls in a dryer fabric run, including all the return rolls and all the pocket rolls, should be parallel to one another and to the dryer cylinders. If any roll is out of line, the seam will react by showing a front-to-back misalignment. The magnitude of the effect of a single out-of-line roll is dependent on the amount of wrap on that roll.

Thus, pocket, hitch, corner and stretch rolls are potential problem points. When a fabric encounters a misaligned roll, the edge that has the shortest distance to travel will begin to move ahead – causing a misalignment bow. Changes in roll diameter can also be the culprit. Rolls may be reduced in diameter by wear or abrasion. An increase in diameter can result from buildup of stock, rust or other foreign materials. If one side decreases or increases diameter more than the other, the result will be a front-to-back misalignment bow.

Correction of Symmetrical Bows

Replacement of deflecting rolls with either stronger rolls or larger diameter will normally solve a symmetrical bow problem. However, this can be a costly operation. Old rolls can also be removed from the machine and resin or rubber covered to add enough stability to prevent sagging or deflection.

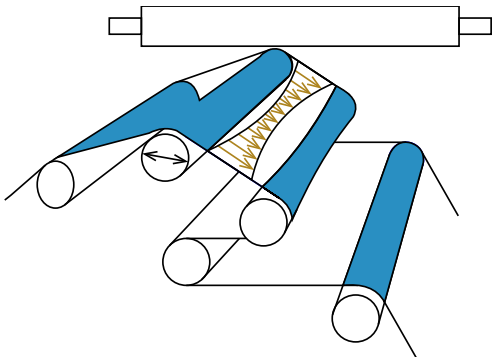

FIGURE 3.

It may be more practical to install concave rolls (See Figure 3). The installation of one or two concave rolls will usually eliminate even an extreme symmetrical bow. In a concave roll, the center has a smaller diameter than the edges. At any given RPM, the surface speed of any point on the roll varies with the circumference at that point. Thus, the middle has the lowest speed and the edges have higher speeds.

This causes the edges of the fabric to run ahead to correct the symmetrical bow. Proper placement of a concave roll and the amount of negative crown required are dependent on a complex set of factors – beyond the scope of this discussion. Any mill considering the use of concave rolls would be well advised to consult with a dryer fabric supplier whose applications engineers can make the necessary computations and recommendations.

Correcting Front-to-Back Misalignment Bows

If buildup of stock or contaminants on roll surfaces is causing misalignment, the rolls should be scraped or cleaned as required. If wear or abrasion causes roll diameter differences, roll replacement or recovering may be necessary.

If all rolls in the section are in good condition, they may need to be realigned. Theoretically, the ideal solution is optical alignment. Since most mills do not have either equipment or personnel with the required training, the services of a consulting engineer are often required. In most cases, optical alignment is time-consuming and expensive. In many cases, a less complex and time-consuming technique can provide the necessary corrections.

The taping method is one such technique that can be carried out by mill personnel. A step-by-step description will illustrate its use.

The first step was to make a side elevation sketch shown in Figure 4. The rolls with the greatest amount of wrap in the return run were labeled A, B, C, D, E, F and G. The pocket rolls, including the tail roll, were numbered 1 through 7.

The rolls indicated as guide and hand guide rolls were not considered. These rolls are moved constantly during day-to-day machine operation, and they do not distort the seam even when cocked to one side or the other. The same is true for fixed rolls with little wrap; they are seldom the source of significant misalignment problems.

After the drawing was completed, one of the rolls in the return run needed to be established as parallel to the dryers. This roll then became the reference roll for other rolls in the run. The reference roll is established by taping around one of the dryers and a felt roll at the front and back to ascertain that they were parallel. This can also be accomplished through the use of a plumb bob if it is not possible to tape.

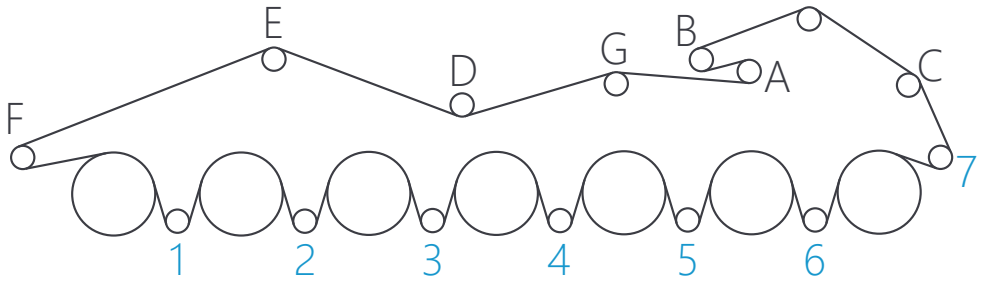

FIGURE 4.

Rolls	F/S		B/S		Diff.		Pocket Rolls	F/S		B/S		Diff.	
A-B	5.259 m	17′ 3-1/16″	5.263 m	17′ 3-1/16″	.32 cm	1/8″	1	18.4 cm	7 1/4″	18.4 cm	7 1/4″	0	0
B-C	8.597 m	28′ 2-1/16″	8.587 m	28′ 2-1/16″	0	0	2	18.6 cm	7 5/16″	18.7 cm	7 3/8″	.16 cm	1/16″
D-E	9.770 m	32′ 5/8″	9.765 m	32′ 7/16″	.48 cm	3/16″	3	18.4 cm	7 1/4″	18.4 cm	7 1/4″	0	0
E-F	11.111 m	37′ 7/16″	11.111 m	37′ 7/16″	0	0	4	18.6 cm	7 5/16″	18.6 cm	7 5/16″	0	0
							5	18.6 cm	7 5/16″	18.6 cm	7 5/16″	0	0
							6	18.7 cm	7 3/8″	18.4 cm	7 1/4″	.32 cm	1/8″ Tight B/S
							7 (tail roll)	78.1 cm	31 1/4″	79.1 cm	31 1/8″	.32 cm	1/8″ Tight B/S

With the reference roll established, the systematic check could proceed. In the side elevation drawing shown in Figure 4, Roll B was established as the reference roll parallel to the dryer. The next step was to check Roll B vs. Roll A – the stretch roll. The stretch roll is a good place to start the procedure, as it travels in a movable carriage and often becomes misaligned.

A 30-meter (100-foot) steel tape measure was used to check roll alignments in the return run. Both rolls, which face an equal distance in from the front side, were taped. This figure was then recorded on the chart, as in the case of Rolls A to B front, 5.259 m (17 feet, 3 1/16 inches).

The same procedure was repeated on the back side of the machine, and the dimension entered on the chart - Rolls A to B back, 5.263 m (17-feet, 3-3/16 inches). The difference between the two dimensions, 0.32 cm (1/8-inch), is entered in the difference column.

Since the difference was determined by taping around two rolls, the actual misalignment, .16 cm (1/16-inch), was half the difference between front and back dimensions. This .16 cm (1/16-inch) was the distance the roll would need to be moved to bring it back into perfect alignment. On the machine in this example, the stretch roll misalignment was in the proper direction to help cause some seam distortion. Nevertheless, the amount of misalignment was so small that it could be further for the cause of misalignment. Rolls B to C were checked, and no misalignment was found.

The 30 m (100-foot) tape was then used to measure around Rolls D and F, and they were found to be exactly parallel. Rolls F and G were then taped and proved parallel. Having gone through the entire return run without finding appreciable misalignment, attention shifted to the pocket rolls.

As noted on the chart, Roll 2 was found to be .16 cm (1/16-inch) off in the proper direction to cause the observed seam distortion. Again, this small misalignment was considered insignificant.

Further checks revealed that Roll 6 was .32 cm (1/8-inch) out on the back side, again in the proper direction to add to this section's seam distortion problem.

Since the pocket roll is wrapped 180-degrees, the distance the felt edge travels is twice the misalignment. In fact, for every revolution of the fabric, the back side has .64 cm (1/4-inch) farther to travel than the front side.

The last roll checked in this section was Roll 7, the tail roll. This roll was checked in reference to the bottom dryer and found to be 1.09 cm (7/16-inch) low on the back side. The deviation was identified as the primary cause of seam distortion. The other small misalignments noted above added to the problem but were minor in impact.

It was recommended to the mill that they correct the alignments of tail Roll 7 and pocket Roll 6, then observe the seam for a while to see whether these corrections would minimize the seam distortion. It could then be determined whether or not it would be advisable to make the effort to correct the other rolls found to be out-of-line by lesser amounts.

The procedure described above is a fairly thorough and rapid check of dryer section alignment at a minimal expense. While this method does not provide the precision of optical alignment, it is adequate for the purpose of correcting dryer fabric seam distortions.

Summary

1. Symmetrical bows, where edges run even and the center runs ahead, are usually caused by roll deflection.
2. Roll deflection may be caused by excessive fabric tension. Tension should not exceed 1.05 to 1.40 kN/m (6 to 8 pli) unless the machine is designed to run at higher tensions.
3. Deflection resulting from weakening of aged rolls can be corrected by replacing or recovering rolls.
4. A concave roll running at higher surface speeds on its edges may be used to correct a symmetrical bow.
5. Either type of bow may be caused by increased roll diameters from accumulation of stock, rust or contaminants on the roll face; rolls should be scraped or otherwise cleaned.
6. If wear or abrasion causes roll diameter differences, roll replacement or recovering may be necessary.
7. Front-to-back misalignment bows usually indicate misalignment of one or more rolls in the section.
8. The magnitude of effect of a single out-of-line roll varies directly with the amount of wrap on the roll.
9. The taping method is a quick and inexpensive alternative to optical alignment for the purpose of correcting dryer fabric seam distortion.

Questions?

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