

Minor Machine Adjustments Help Mills Meet Latest Containerboard Standards

STFI/ring crush can be improved by simple process modifications and use of proper forming fabric to maximize first pass retention

By Roy Jones

Traditionally, corrugating medium machines ran to a standard concore for standard basis weights of 26 to 40 lb. Linerboard machines ran to mullen (burst strength) at standard weights of 26 to 90 lb./1,000 sq. ft. Other tests, such as STFI (STFI is a short-span, compressive-strength test developed by the Svenska Traforskinings Institute, or Swedish Forest Products Research Laboratory) and ring crush were monitored on some machines, but operations were seldom controlled to meet these standards.

With recent changes in truck and rail packaging rules, many brown paper machines will run to different standards. The rail carriers Uniform Freight Classification – Rule 41 revision became effective this past January 26 and the National Motor Freight Classification – revised Item 222 became effective on March 30.

Some mills have already stopped testing concore and mullen and run the machine to produce a certain STFI or ring crush at whatever basis weight it takes. Most likely, this is for corrugating medium:

- M11 – minimum of 11 STFI at whatever basis weight, replacing the 26-lb. classification.
- M15 – minimum of 15 STFI at whatever basis weight, replacing the 33-lb. classification.
- M19 – minimum of 19 STFI at whatever basis weight, replacing the 40-lb. classification.

Linerboard will have similar STFI or ring crush standards to replace mullen.

With STFI, a 15 mm wide strip, cut in the cross direction (CD), is held between two jaws, 0.7 mm apart, and pushed inward to give buckling failure (Figure 1).

With the ring crush test, a machine direction (MD) strip is rolled to form a ring and then crushed between two horizontal plates as shown in Figure 2.

FACTORS AFFECTING STFI/RING CRUSH.

Obviously, many more factors affect these tests than can be covered in this article. For example, high-impulse pressing as well as multi-ply machines that improve CD

stiffness through an I-beam effect of the two outer layers separated by a third inner ply are used to improve STFI and ring crush. However, this article focuses specifically on things that can be done to improve these test values with only minor modifications to the existing machine.

As a broad classification, STFI and ring crush depend on fiber quality, orientation, and distribution. The following variables have a major impact on these aspects of the fiber:

- Process changes
- Forming fabrics
- Fourdrinier dewatering equipment

FIGURE 1: With the STFI test, a 15-mm-wide strip cut in the cross direction is held between two jaws, which are 0.7 mm apart, and pushed inward to buckling failure.

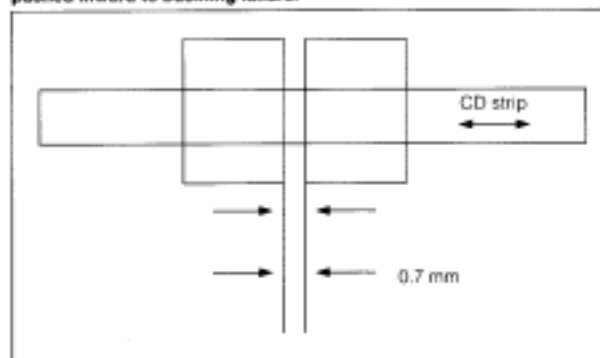


FIGURE 2: To test ring crush, a machine direction strip is rolled to form a ring and then crushed between two horizontal plates.

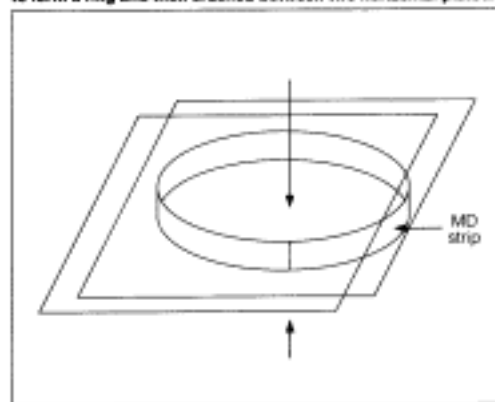
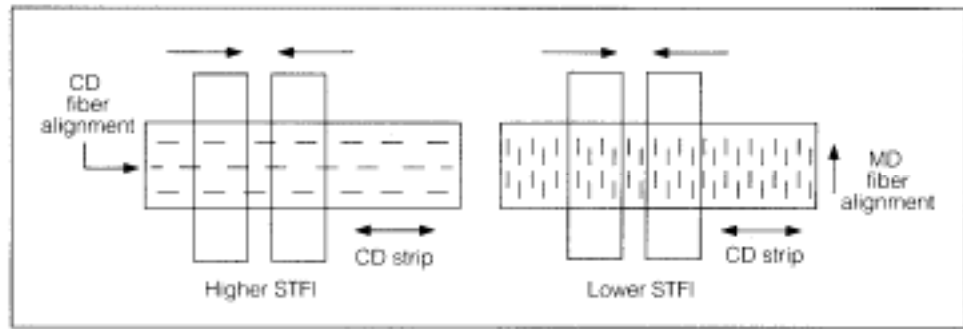


FIGURE 3: Higher STFI values are obtained when fiber alignment is in the cross machine direction.



Process variables include those occurring in refining, those inherent in the furnish, and those that are headbox induced (resulting from dilution and rush/drag adjustments). Forming fabric variables include first pass retention, fiber distribution, ply bonding, and sheet surface/wire impression. In addition to dewatering variables at the wet end, some mills report that drying and calendering also influence STFI and ring crush.

PROCESS CHANGE. Refining represents a significant variable at most mills. Normally, gentle refining with low yield pulping and increased refining with high yield cooking give the best results. Fiber length is obviously important since, with the STFI test, the clamping length of the test specimen is only 0.7 mm, which is less than the length of long fibers (up to 2 mm). Individual fiber compression failure is therefore a major factor.

As far as furnish variables are concerned, hardwood fibers are reported to be more bondable than softwood fibers, yielding better compression strength, especially when used with high impulse pressing.

Increased dilution at the headbox normally produces a more uniform sheet but may have a slight negative effect on compression strength because of reduced first pass retention. Good formation reduces the weak spot failure in compression testing.

Rush/drag is one of the single most important factors in developing CD fiber alignment necessary for good STFI and ring crush values (Figures 3, 4 and 5). In this regard, mills should give primary consideration to the following:

- Establishing the true zero rush/drag relationship on each individual machine by reel width measurements or pitot tube jet velocities.
- Using absolute differences in jet and wire speeds – and not ratios.
- Maintaining a 35-ft. rush (push) above actual mill established zero rush/drag (although actual values may vary slightly), which has been found to develop maximum STFI/ring crush while holding good concora and mullen values.

FORMING FABRICS. There is considerable confusion within the industry regarding the varying classifications of forming fabrics, which include single layers, 1½ layers, double layers, extra strand/X-picks, and triple layers. The desirable fabric to produce high STFI/ring crush is one that maximizes first pass retention and minimizes wire impression.

First pass retention. Assuming a reasonably closed mill back water system (and not a system where the majority of fines are sewerred), highest machine efficiency and test values are obtained when the fiber is

FIGURE 4: Higher ring crush values also result from a cross direction fiber alignment.

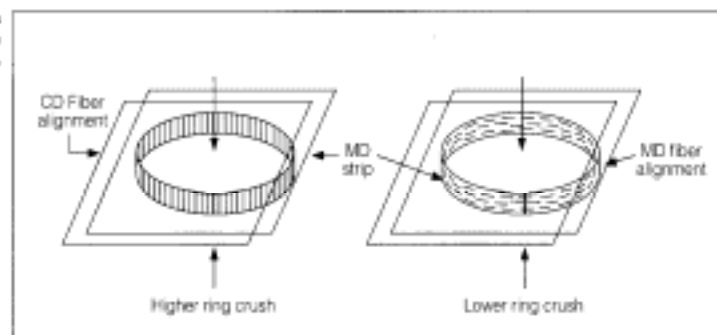
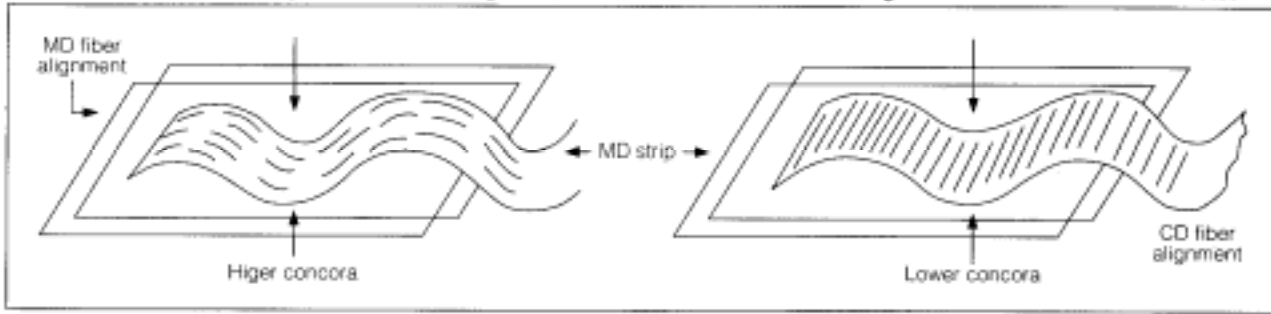


FIGURE 5: Concora is normally obtained in the drag mode, where machine direction fiber alignment resists the crush of the flutes.



refined to its maximum strength potential and taken to the reel the first time. The more times some of the stock is re-circulated through the system (resulting in lower first pass retention), the worse the fiber – and hence sheet strength and runnability – becomes.

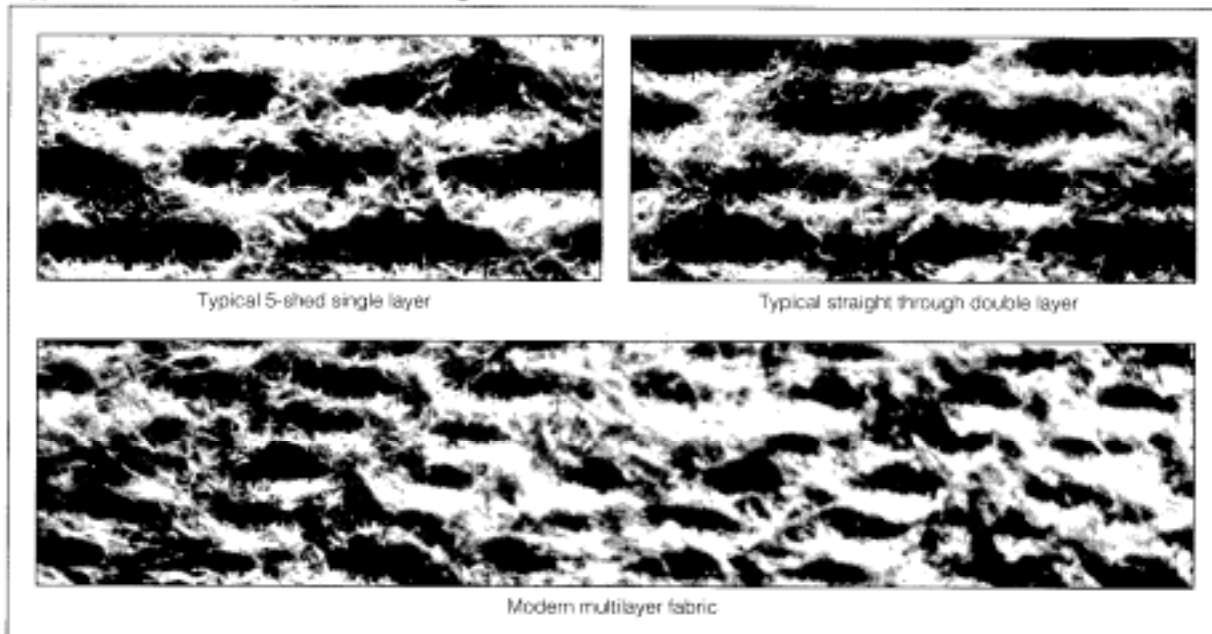
The higher the forming fabric fiber support index, the higher the first pass retention. This should be accomplished in conjunction with a high drainage index, which also takes permeability into consideration. Also in the push mode desirable for CD fiber orientation, table drainage is normally reduced so that a higher drainage index fabric is desirable. Then, all other things being equal, the higher the first pass retention, the better the quality of fiber and hence the better the STFI and ring crush (longer fibers produce better columns to resist compression than shorter fibers).

A comparison of a true double-layer Weavexx TITAN 445 with typical low density double layers and a typical 5-shed is shown in Table 1. Many cases are documented where the TITAN double-layer fabric has produced 1.0 to 1.5 extra points of STFI on 26-lb. corrugating medium and 42-lb. linerboard over other types of fabrics.

Fiber distribution. Higher first pass retention results in less fines in the headbox, which results in less fines on the top side of the primary and secondary sheets. This affects the position of the neutral axis in the sheet and the resistance to buckling.

Since STFI and ring crush fail in eventually buckling the outside fiber layer, a greater concentration of long fibers at this area will give higher test results.

FIGURE 6: A comparison of sheets made with various linerboard fabrics shows that a smoother surface results from the higher fiber support fabric, which should improve STFI and ring crush values.



Ply bonding. For machines forming a multi-ply sheet, STFI and ring crush failure can occur due to ply separation. The better the quality of the fiber at the surfaces that comes together at the bonding point, the stronger the ply bond. Conversely, the greater the amount of “fines dust” on the surface caused by lower fabric fiber support and lower first pass retention, the lower the ply bond and STFI/ring crush.

TABLE 1: The fiber support and drainage indexes for a true double-layer fabric are significantly higher than those for single-layer and low-density, double-layer fabrics.

Description	5-Shed, single-layer	Low-density, double-layer	TITAN 445
Mesh, total	46 x 42	47 x 72	111 x 90
Top	46 x 42	47 x 36	74 x 60
Bottom	—	47 x 36	37 x 30
cfm	670	550	700
Fiber support index	63 to 68	64	97
Drainage index*	22 to 26	19.8	30.6

*Drainage Index = $\frac{\text{FSI factor "B" x CD mesh x cfm}}{1000}$

Sheet surface/wire impression. Although not verified by actual testing, it seems reasonable, considering the mode of failure of the STFI tester, that surface imperfections in the outside layer of the sheet would more likely promote compressive failure than a smooth, flat sheet. The surface of sheets made on various linerboard fabrics is shown in Figure 6. Apart from promoting easier sheet release at the couch, the higher fiber support fabric should improve STFI and ring crush because of its smoother surface.

EQUIPMENT VARIABLES. Since there is a very high degree of MD fiber orientation coming out of the headbox slice (as with logs aligning in a stream), providing agitation as soon as possible after the jet hits the wire is desirable to promote the necessary CD fiber alignment for high compression strength. Machine elements that induce turbulence independent of drainage have been found to improve STFI and ring crush. This should be done directly after the forming board before the point of sheet set is reached.

During drying, the degree of both CD and MD sheet restraint can also have a significant influence on compression strength of the finished product. A tighter draw normally promotes higher STFI/ring crush as does the use of dryer fabrics vs the unfelted arrangement.

Some companies report that calendaring can cause a significant reduction in STFI and ring crush due to fracturing of the actual fibers. Calendaring does not improve bonding but does reduce caliper, thereby reducing CD stiffness and ring crush.