Fiber cores—technology to meet industry requirements*

DENICE R. OSBORNE

Demands for bigger, wider, and faster presses reverberate straight to the core of the paper roll.

As pressrooms and converters install more sophisticated equipment to improve their productivity and mills respond with operating and equipment changes, core manufacturers are challenged to redefine fiber core performance attributes. Five major innnovations in the paper and printing industries—wider web widths, faster press speeds, larger diameter rolls, surface-center drive single-drum winders and the elimination of metal pipe and ends—are aimed at increasing productivity for the pressrooms and converters, the ultimate customers.

In the last few years, the rotogravure printing industry has seen web widths expand from 96 to 125 in. The 137-in. press is a reality in Europe. The newsprint industry has also seen changes in the presses, with the increased use of expandable chucks. The replacement of the conical chuck with the expandable chuck is allowing the core industry to remove metal ends and inserts from many cores. Other advances in newsprint include the conversion from standard newsprint paper to rotonews that require an upgraded core in most cases. The offset printing industry has experienced the introduction of the Harris M 3000 Sunday Press, which is capable of running 50-in. diameter rolls at speeds of 3000 ft/min. The offset industry also continues to use a wide variety of unwind stands and chuck styles. These developments in offset are creating situations which require upgraded cores and decreased use of metal ends.

These advancing technologies affect the paper mills' winding operations and the pressrooms and converters unwinding operations. As a result, the fiber core manufacturer of the nineties must be able to deliver cores that perform under much greater loads and stresses than ever before. The cores must provide for smooth effective winding and contribute to good roll structure even with 50-in. roll diameters, lengths up to 125 in., and roll weights exceeding five to six tons. The pressrooms and converters expect these paper rolls to run trouble-free without vibration, web flutter, or breaks at speeds exceeding 3000 ft/min. The advantages of the larger roll diameters are fewer web breaks. Several paper mills have received charges from the pressroom when excessive web breaks occur due to flutter and vibration of the rolls on the unwind stands. The needs of the pressrooms and converters for the reduction of web breaks emphasize the importance of understanding the interaction between the winder and the core in role structure and critical speed performance.

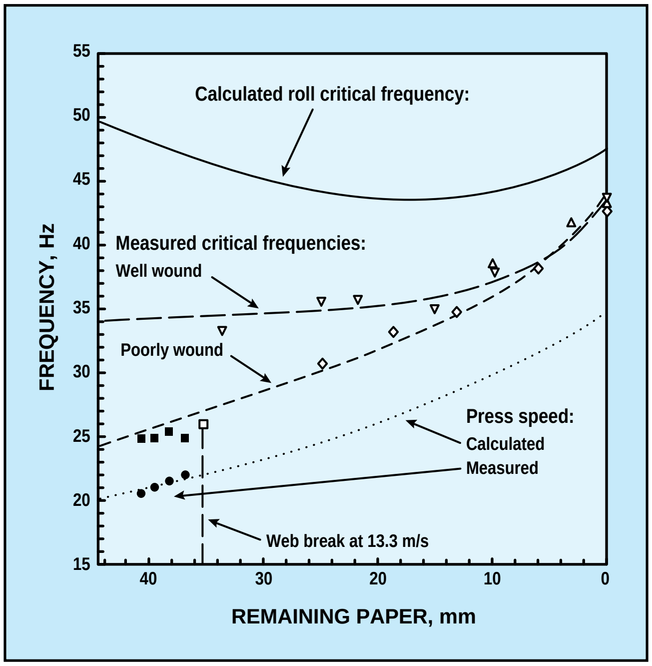
1. Tester used in measuring dynamic load potential

Innovations in winding and core equipment

In the paper mills, innovations in winding technology have had the greatest impact on operations. This technology is linked directly to the two basic approaches to winding: roll supported or core supported. These winders have various forms of drives, which are surface, center, and surface-center drive *(1)*. The two-drum winder has been commonplace in the industry for years. This roll-supported winder with the surface drive is the least demanding on cores. The critical attributes for

*This article is an edited version of D. R. Osborne's technical paper of the same title appearing in the *1995 TAPPI Finishing and Converting Conference Proceedings,* TAPPI PRESS, Atlanta, p. 241.

2. Paper roll critical frequency compared to press operating speed



3. High-performance paper mill core performance matrix

MAXIMUM PRESS SPEED, ft/min	78 in.	85 in.	90 in.	96 in.	108 in.
MAXIMUM WEB WIDTH	78 in.	85 in.	90 in.	96 in.	108 in.
EST. ROLL WEIGHT (lb)	4450	4850	5100	5550	6200
1500	A 4500	B 5200	B 5300	C 6900	C 7100
2000					
2500					
2800					
3100					

the successful winding of a fiber core on this winder are: outside diameter to ensure consistency in the wrap tension of the roll, length control to eliminate offset rolls, straightness to eliminate bouncing on the startup while providing smooth and stable rotation throughout the roll construction, and square ends for ease of startup and consistency in roll structure.

The vertical two-drum winder, the early version of the single-drum winder, is a core-supported or surface-drive winder developed for winding larger diameter, heavier rolls, which exert a tremendous stress on the cores. The critical attributes for cores on the vertical two-drum winder are dynamic strength to ensure no core delaminations, stiffness to ensure no core bending at the startup, inside diameter for proper core chuck fit, and axial strength to withstand the side loading pressure exerted by the chucks.

The shared attributes between the double-drum winder and the vertical two-drum winder are straightness and length consistency. Another version of the core-supported winder is the single-drum winder with the surface-center drive. The single-drum winder has the same core requirements as the vertical two-drum winder.

Unlike the horizontal two-drum roll-supported winder, the single-drum roll supported winder with the center drive or the surface-center drive is more sophisticated. The single-drum roll supported winder relieves a significant portion of the roll weight as the roll is built. This configuration allows for building larger and heavier rolls with better roll structure, throughout the entire roll. Although the weight is relieved during winding, the entire roll weight is still carried by the core during the unwinding. The critical core requirements are dynamic strength, straightness, stiffness, inside diameter, and length.

Another important equipment area that is continuing to evolve is the design of chucks and shafts. These vary widely with each winder and unwind stand for presses and sheeters. The chucks and shafts can be distinguished by two classes: friction and expanding. Generally, the friction chucks are conical shape—with or without lugs. The expanding chucks are cylindrical shaped. The expansion of the chucks is activated by torque, pneumatic, or hydraulic methods. The expanding shafts are designed with similar technology to the expanding chucks. The chucks on all equipment have a major influence on core performance in dynamic load, critical speed, and chewout. Understanding this core–chuck interaction is a critical component of understanding overall core performance. In fact, some of the chucks currently in use were initially designed for metal ends or metal pipe. With the improved high-performance cores now available, metal pipe and most metal ends can be eliminated.

New technologies redefine core attributes

Historically, *flat crush strength* had been the primary performance measurement by which fiber cores were developed and sold to paper mills. The term “flat crush” refers to the strength component that keeps the roll intact until unwinding. It is the ability of the core to withstand the stresses of handling and shipping without collapsing. Once the roll comes off the winder and is stacked by clamp trucks, moved again for loading and transportation, then unloaded and stacked in a warehouse—sometimes for several months—the paper roll may have been handled up to 10 times before ever reaching the printing or converting operation.

Advances in pressroom and converting technologies required the expansion of core attributes to include other criteria. *Dynamic strength capacity* is the ability of a core to sustain heavy, cyclic loading associated with winding or unwinding large rolls of paper that causes compression of the core wall directly over the chuck. This loading leads to delamination or chewout failures of the core—hence a dynamic load failure. *Dynamic load* is a force that can be reproduced in a laboratory test and thus can be a predictor of a core's ability to carry given roll weights (Fig. 1). *Maximum roll weight capacity* of a core is defined as the ability of a core to support large, heavy rolls of paper. This characteristic depends on the type of winder, winder drive, and the chucks for winding and unwinding. Cores must be designed with this as part of the criteria. The maximum roll weight capacity of cores has been determined from extensive field trials and laboratory data, and has been shown to correlate directly with dynamic strength performance *(2)*.

The attribute of *inside diameter* (ID) fit is essential to proper winding on core supported winders and unwinding. During the unwinding process, proper ID fit aids in maintaining the proper web tension. If the core ID is too small, core chucks will damage the end of the core, leading to compacted paper and resulting in roll bouncing and early pasting by the printers. If the ID is too large, the core will not be held properly by the chucks, thus resulting in slippage and chewout. This phenomenon of chewout is difficult to distinguish from a dynamic load failure in later stages. Chewout is an important performance attribute and one that is continuing to receive research and development attention.

Critical speed is the maximum web speed that a core can withstand during unwinding in the printing or converting operation (Fig. 2). This parameter depends on the web width, the roll quality, and the type of paper wound on the roll as well as core design characteristics. Not having the proper roll quality or core design can result in vibration that can cause web breaks and core explosions. Extensive study has been conducted on this subject by Gerhardt, Staples, and Lucas *(3)*.

The core characteristics that contribute to critical speed performance are core straightness or the lack of bowing/warpage over the length of core. The straightness enables proper core trimming, winder startup and productivity, roll structure, and press performance. Beam strength and stiffness are important as the length increases. The wider webs require cores that do not bend or flex and remain straight. In addition, the core must provide resistance to vibration or oscillation when the web is expiring. Web flutter may cause a web break, loss of printing registration, excessive paper waste, or even a core explosion.

The *axial strength* of a core prevents buckling under the forces applied by the chucks of the winder. When improper axial core strength is designed in a core, the delamination failure appears to be similar to a delamination failure in dynamic loading. The common applications are newsprint, offset printing, and converting. Hence, the core design must prevent excessive end-to-end loading.

Moisture content of the core can enhance or degrade the core performance. The Composite Can and Tube Institute (CCTI) Technical Committee has documented the effects of moisture content on flat crush, axial crush, beam strength, and dimensions. The changes due to moisture are quite obvious since paperboard is a hygroscopic material. Thus it is very important that moisture contents and relative humidity of mills, pressrooms, converters, and storage conditions be taken into consideration *(4)*.

Today, and in the future, many other factors such as the ability to resist vibration at high winding and unwinding speeds and dynamic strength performance are the keys in the purchasing of cores. The different levels of these required characteristics determine the type of core to be used. The benefits for each mill customer are dependent on the performance expectations of the core to ensure high productivity. The considerations need to be carried even further to the customer's customer—the pressroom or converter. The customer should inform the paper mill of changes and productivity increases on the horizon. This interaction will prompt the development of new cores that not only increase productivity but advance the benefits of pressroom automation.

The matrix solution to core choice

How do the paper mill personnel select a core that meets dynamic strength, maximum roll weight capacity during winding, and still meets the demands of increased web width and press speed for the pressrooms? The development of a matrix, addressing the roll weight capacity to maximum press speed of a core, resulted from extensive laboratory and field testing. Due to the uniqueness of each paper mill and its customer base, there is no generic matrix that applies to all applications. The matrix does address the issues of paper grade and density, chuck types, and roll structure. Paper mills can use this matrix as a guideline that enables them to select the proper core resulting in optimum performance from the presses and converting equipment (Fig. 3).

How important is the right core? The cost of a paper roll is ever increasing in today's market—approaching US$ 4000–5000 per roll and higher—as compared to the core that is only a few dollars. Yet the core serves as the carrier for winding, transporting, storing, and then unwinding the paper roll. If the core fails during any of these steps, the paper roll will not run properly, jeopardizing thousands of dollars of product. Choosing the right core is crucial, because the right core ensures optimum performance through every phase of production.

Literature cited

1. Roisum, D. R., *The Mechanics of Winding*, TAPPI PRESS, Atlanta, 1994.
2. Staples, J. F., *TAPPI 1993 Finishing and Converting Conference Proceedings*, TAPPI PRESS, Atlanta, p. 241.
3. Gerhardt, T. D., Staples, J. F., and Lucas, R. G., *TAPPI 1992 Finishing and Converting Conference Proceedings*, TAPPI PRESS, Atlanta, p. 268.

4. CCTI Technical Committee Report TCR—2. “The effect of moisture content on dimensional stability and strength properties of a typical paperboard tube or core,” 1989, pp. 1–6.

A special thank you to the Global Paper Mill Core team at Sonoco, who provided the technical and marketing data used in writing this paper. Thank you to the Research and Development Group for the numerous hours of testing and accumulating data from the field.

Osborne is a research and development engineer at Sonoco Products Co. in Hartsville, SC.

Core conversions and reclamations

As quickly as the publications papers industry is converting from pipe to fiber cores, innovations in these cores are occurring just as rapidly. Scott Pleune, marketing manager for Sonoco Products Co., ties the success of the conversion to “the compressibility, straightness, and consistency of the fiber core, which allows for a good tight roll start on the paper mill’s winder. This is the major consideration—along with safety and economic concerns—for choosing the fiber core.” While high-strength fiber cores are becoming more advanced and specialized, with different cores being developed to meet very specific speed and weight requirements for wide web gravure applications, innovations are also occurring in other markets.

Take, for example, the case of the *Baltimore Sun* (Baltimore, MD), a newspaper with a circulation of two million copies weekly. A couple of years ago, the *Sun* moved its entire printing operation to a new plant and installed four new Goss® CT-50 presses which meant switching from 45- to 50-in. rolls. The pressroom continued to use an unslotted standard fiber core with metal-ends on the new presses, which resulted in a substantial increase in costs related to out-of-round rolls, web breaks, and downtime during the transition from not only one pressroom to another but to presses now running larger diameter rolls. The *Sun’s* newsprint supplier, Garden State Paper Co. (Elmwood Park, NJ), determined that the problems were not caused by manufacturing errors, but that an upgraded core was needed to support the weight of the larger rolls.

Sonoco Products, Garden State’s core supplier, convinced both the *Baltimore Sun* and Garden State to switch to a beveled-end, nonreturnable core that enhanced both winding at the mill and runnability at the pressroom. Since the core’s beveled end assured a secure fit in the roll stand, metal ends were eliminated and the core’s integrity remained protected from misalignment, splitting, and crowding—those potential problems during unwinding.

This particular beveled-end core provides room for a conical pneumatic chuck to bite and set the core without cracking, so the chuck is consistently seated for smooth, high-speed printing. Constructed with super-strong proprietary paperboard, the core withstands the additional stresses on the inner surface that cause core chewout and web breaks.

1. A beveling machine, set up at Garden State Paper Co., has led to increased efficiency at both the mill and the pressroom.

Since the beveled core reduced web breaks by 35% and therefore reduced total system costs, the only problem facing the *Baltimore Sun* now was what to do with the nonreturnable core.

Sonoco’s reclamation program

As paper mills and pressrooms became believers in the benefits of high-strength fiber cores in replacing metal pipe and standard fiber cores with metal ends, the Industrial Products Division of Sonoco Products Co. took action to resolve the problem of what to do about that nonreturnable core. The solution came in establishing a nationwide reclamation/recycling program, which provides customers and end-users with an easy, economical means to dispose of and recycle cores, cones, and tubes. The program is also in place in Europe. Started in 1991, Sonoco’s core reclamation program is a closed-loop system which reclaims, shreds, repulps, and recycles fiber cores, cones, and tubes into new paperboard carriers and other packaging products. The core customer is motivated to participate in the program because it is the most inexpensive way to dispose of the core, and it avoids the logistical nightmare of dealing with metal pipe and ends.

Sonoco has been in the recycling business for 80 years. The vertically integrated company, headquartered in Hartsville, SC, operates 23 paper mills around the world producing mostly recycled cylinder board—80% of which goes into its own converted paper products. Sonoco accomplishes this feat of maintaining its supply of recycled fiber by operating 22 recycling plants through its subsidiary collection center Paper Stock Dealers in Columbia, SC. It procures old corrugated containers, newspapers, computer paper, as well as a variety of other paper grades.

Today more than 70% of the company's products incorporate recycled material, and many are made from 100% of this material. Annually, Sonoco recycles more than two million tons and is one of the world's largest consumers and processors of recovered paper.

Practicing what it preaches, Sonoco's headquarters recycles more than a ton of its own office waste every week through an organized and committed group effort, which works because recycling is at the financial heart of Sonoco's business.

—Patricia M. Pauksta
Tappi Journal *News Coordinator*

2. Sonoco's Reclamation/Recycling System reclaims and processes a wide variety of fiber cores and corrugated packaging into new fiber carriers and other packaging products.