Press rolls with resin composite covers to replace granite roll

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The release requirements of plain hard rolls have become critical as paper machines have reached elevated press loadings and temperatures for newsprint, fine papers, and publication grades. The increased use of recycled fibers has also had an adverse impact on sheet release.

Three serious breakdowns involving granite rolls took place in Scandanavia in 1987. The granite rolls disintegrated, causing serious damage to other rolls as well. As a result, a study was undertaken to determine the potential of rolls of various materials and designs to replace granite rolls. This study, by "The Granite Roll Group" of Sweden, indicated two types of potentially satisfactory alternative covers: a synthetic resin cover with fillers cast on a metal core and a ceramic coating plasma sprayed on a metal core (*1*).

Although hard rubber covers have been used successfully in various applications, the high speeds and high loads have been encroaching on the endurance limits of these rolls (*2*). The limitations of rubber and polyurethane covers relating to temperature, release requirements, and fiber furnish became apparent when they were evaluated in center and top positions in the wet press (*3*).

It was thus the objective, when developing the resin composite cover, to manufacture a product that was not only a granite substitute but also a replacement for other "hard" roll covers used across a wide range of paper grades. This objective was realized with the successful introduction of steel rolls with resin composite covers in Europe, beginning in late 1987.

Background

To understand the release characteristics of the resin-covered roll, it is first necessary to review those properties of granite that have contributed to its successful use in paper machine wet presses.

The quartz, feldspar, and mica components of granite create a nonhomogeneous porous structure (Fig. 1, left) with a surface that varies in roughness. Not only does this surface resist abrasion under doctor roll loadings, but it also has a favorable effect on sheet release. The rough, porous surface interrupts the film of the roll surface water, which disturbs the adhesion forces between the sheet and roll surface. The sheet release is also influenced by the contact angle of the surface water, a function of the free surface energy of the system (*4*). In addition, the mineral particles of granite combine to produce a surface pattern that is both hydrophilic and hydrophobic, distributed in an overall inert structure. This combination also causes an interruption of the water film and aids in sheet release.

1. On the left, granite (520X) shows the random occurrence of mica and feldspar. On the right, the resin composite (520X) shows the homogeneous dispersion of special additives.

Being nonuniform in porosity and structure, however, the granite roll also has adverse effects on the uniformity of release (*5*). In addition, granite absorbs water to such an extent that it can cause changes in sheet release during startup.

The new roll with resin composite cover is designed to achieve the efficient sheet release of a granite roll. On the other hand, the unfavorable characteristics of granite have been avoided in the new roll, which has a homogeneous surface (Fig. 1, right) without the detrimental water absorption effect. These properties are compared in Table I.

Physical properties

As shown in Fig. 2, the resin cover is made up of the base and the cover surface. The base consists of the cover substrate and adhesive system. Because of the extreme hardness, a suitable substrate and compatible adhesive system had to be developed to accommodate the difference in the coefficients of thermal expansion between the metal core and the resin cover. Before the resin is cast, a composite base layer is applied to the metal core. The resulting cover structure has a high thermal stability (Fig. 3), which allows it to be used in steam box positions or in roll stacks having steam boxes.

The cover surface consists of a homogeneous dispersion of special hydrophilic and hydrophobic filler particles in an electrochemically neutral resin matrix. This surface structure combining forces that repel and attract water

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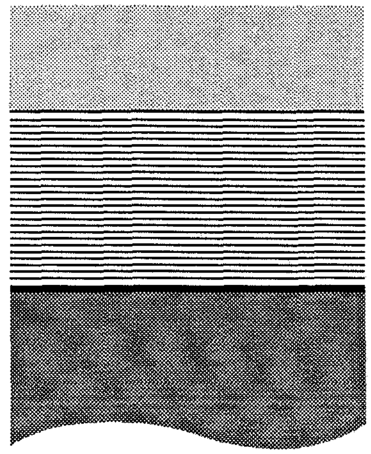
I. Comparison of qualities of the granite and resin composite rolls

	Granite	*Resin composite*
Water absorption,* % by wt.	3-4	<0.5
Tensile strength, mPa	6.9-10.3	82.7
Coef. of linear expansion, per °C	8×10^{-6}	4×10^{-6}

*Tests were conducted by immersing samples in 65°C water for 8 weeks.

2. Structure of the roll with resin composite cover



was designed after the surface of granite. The composition of the special fillers is selected to match the specific grade of paper to be produced.

The roll has excellent physical properties, which makes it suitable for top and center positions in the press. This new resin composite roll cover is superior to the granite roll in that the new cover has a higher tensile strength and a lower coefficient of linear expansion (Table I).

Operating requirements

The center press and top press positions on newsprint, fine paper, and publication grade machines require a cover that is both hard and thermally stable. With resin-covered rolls, the shell deflection should be a maximum of 0.025 mm of deflection per meter of cover length. This limit is imposed because of the hardness (91 ± 0.2° Shore D) of the cover material.

In general, because of the inherent thermal stability at elevated temperatures and the low hysteresis heat effect, the resin-covered roll requires no internal cooling. For example, the heat buildup of hard rolls with elastomeric (rubber based) covers at elevated press loadings and speeds is commonly in the range of 0.03-0.05 kCal/(kg·s), compared to less than 0.01 kCal/(kg·s) for the roll with the resin composite cover. In specific cases, however, the shell supplier may recommend internal cooling to ensure uniform temperature and deflection of the metal across the core face.

Since the highest stress on a roll is usually located along the edges of the sheet, rolls mated with the new hard rolls should be dubbed. In many European arrangements, a double taper is used to minimize stress at the sheet edges. Details of this type of dub are available from the roll supplier.

The surface of the resin composite roll is supplied in a smoothness range of 0.6-3.0 μm, Ra (roughness average). This smoothness can be adjusted to suit specific requirements. (Usually a smoother surface is used on finer paper grades.) The smoother surface optimizes the hydrophilic-hydrophobic release effect of the cover fillers and ensures proper mating of the doctor blade to the roll surface. The resin composite roll cover is smoother than the surface of granite rolls or elastomer-covered rolls.

The cover also has a very high wear resistance (**Fig. 4**). This wear resistance contributes to the maintenance of roll shape and reduces the risk of vibration in the press. As evidence of this high resistance to wear, the covers have been used for two years between regrinds in actual operation.

The resin composite roll is generally resistant to most chemicals used in pulp and paper production, including alcohols, acetone, kerosene, chlorinated hydrocarbons, and mineral nonoxidizing acids. The effect of specific chemicals can be quantified by the roll cover supplier through immersion testing. In these tests, the cover samples are immersed in full-strength chemicals at selected temperatures (65°C and 95°C). Changes in percent weight and volume are measured for periods of 6-12 weeks. An immersion in water under the same conditions is included as a control. In addition, the samples are visually inspected under magnification for evidence of surface chemical attack, such as blistering and pitting.

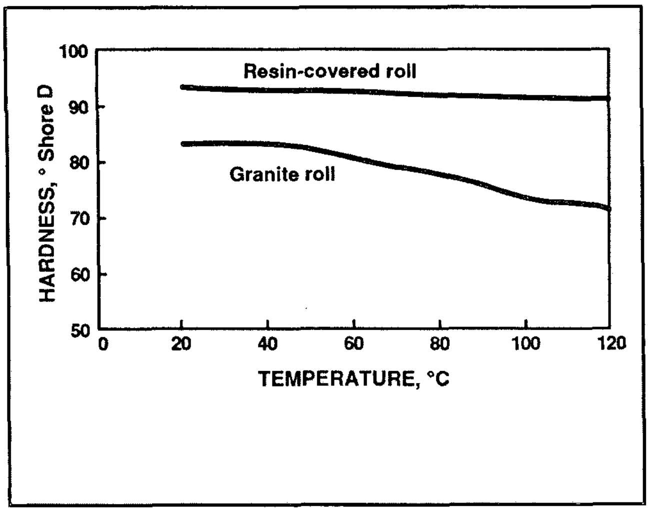
The roll surface should not be hosed with colder water immediately after stopping the machine. The roll should be rotated at crawl speed to reduce the surface temperature to 30°C before applying water. The temperature difference between the cleaning water and roll surface temperature should not exceed 5°C.

Doctor blades

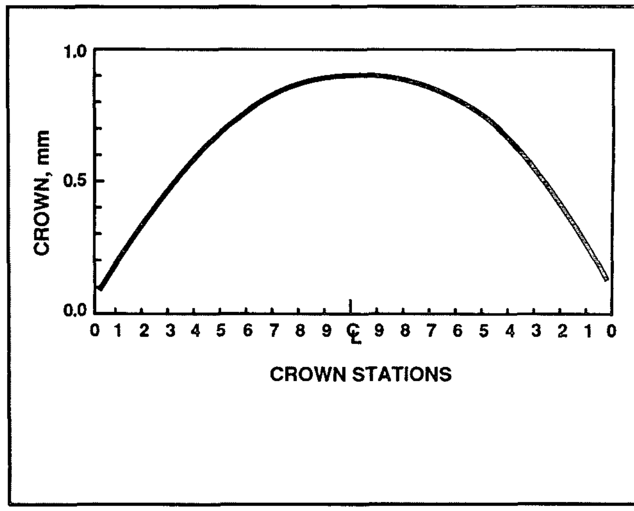
The doctoring of hard press rolls is a primary concern in the successful operation of high-speed paper machines. The resin-covered rolls may be doctored with blades of Series 400 stainless steel (45-49 Rockwell hardness) or nonhardened Monel (30-32 Rockwell hardness). Satisfactory results have also been obtained with epoxy-type blades reinforced with glass fiber. The required doctor blade loading of 70-250 N/m will normally be lower than that necessary with granite rolls because of the cleaner running surface and the good sheet release. This lighter load contributes to a longer life for the doctor blade.

Doctor blade angles of 20-26° (maximum) are normally

3. The effect of temperature on hardness



4. Crown maintenance after 16 months at a machine speed of 800 m/min



used with the resin cover for optimum potential life and to prevent accidental roll damage. Although a number of mills operate without a doctor blade shower, lubrication showers can be used with water temperatures of approximately 40°C and flow rates of 0.8-0.9 L/min.

During startup, potential damage to resin roll covers can be avoided by taking certain precautions:

1. After a blade change, the roll cover surface should be wet thoroughly with hose or water shower. Doctor blades should be lifted off the roll when wetting the surface.
2. The press should be stopped, and the doctor blade should be applied with slightly reduced loading (100-120 N/m).
3. Start the press and continue to apply water to the cover surface.
4. When normal operating speed is reached, doctor loading can be increased to the normal level.
5. As an additional precaution, some mills bevel the doctor blade ends before installing the blade.

During operation, steel or Monel blades should be changed when the machine is stopped to prevent thin worn blades from possibly "hooking" the roll covers.

Grinding

The resin composite roll should be ground, using diamond wheels (62 or 80 grit) that have been properly "dressed" by passing over a rotating iron wheel or by other suitable dressing techniques. The iron wheel dressing method uses a wheel 400-800 mm in diameter rotating at 5-7 rpm across the diamond wheel surface. The diamond wheel is commonly 600 mm in diameter, with a rotating speed of 19-21 m/s. The feed rate is normally 75-100 mm/min during the dressing step.

After wheel dressing, "rough" grinding is accomplished with a roll speed of about 9 rpm and a cross-feed rate of 150 mm/min. Then normal grinding is carried out at 9 rpm also but with the cross-feed reduced to 100 mm/min. Final grinding is completed by progressively reducing the roll rotation to 6 rpm and slowing the cross-feed to as low as 30 mm/min, until the desired surface finish is obtained.

Although it is possible to grind the resin cover with conventional grinding wheels, the grinding times are reduced through the use of a resinoid-bonded diamond wheel.

Storage and transport

The resin cover should be stored at 20-25°C and protected against significant temperature variations. Rolls for shipment should be packaged in strong wooden or steel crates, with the weight of the roll supported on the journals and with adequate clearance (10-15 cm) between the roll cover surface and the container.

The cover can be transported at temperatures down to 0°C. Below this temperature, a heated trailer must be used. Cold roll covers must be allowed to return gradually to room temperature (25°C) before installation.

If the cover sustains moderate accidental damage, the roll can be repaired either at the mill site or at the roll cover plant, depending on the extent of repairs required.

Suitability for North American mills

The higher machine speeds, the use of steam boxes, and the trend toward increased use of recycled fiber will place increasing demands on operating conditions in North American mills. It is expected the successful release characteristics and runnability of the European resin-covered rolls will also be experienced in North America.

The original resin composite roll supplied to a Midwest fine paper machine has been operating for over one year with excellent sheet release and machine performance. This roll has been evaluated against both granite rolls and rolls with hard elastomeric covers. Mill results indicate an average 10% reduction in draw and a generally cleaner running surface, as evidenced by less buildup on the doctor blade.

Other resin composite covers have been supplied with original rolls on new high-speed paper machines in the Midwest and South in the United States. The new rolls are soon to be installed on paper machines for fine papers, newsprint, and publication grades in mills in North America. One is expected to be installed in the top roll position on a corrugating medium machine.

Conclusions

The resin composite roll cover is providing excellent release and runnability in hard press roll positions for a variety of paper grades. Results show that the cover will operate on the fastest newsprint and publication-grade paper machines, using various stock furnishes. The machine performance and sheet release characteristics are equal to or better than those of rubber-covered rolls or granite rolls.□

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CORRECTION

Incorrect name in July article on Rule 41

In the article "New carrier regulations for corrugated shipping containers are now in effect," *Tappi Journal*, 74, no. 7, pp. 63-5, (July 1991), in paragraph two of the section titled "Need for modernization outlined," the name "Miller" should be "Morris."