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Granite roll material and surface requirements

Scope

Most granite rolls have been replaced by rolls with composite or synthetic covers but some stone rolls are still in use. Granite has long been used for paper machine press rolls due to its exceptional release properties. The use of granite for press roll construction dates back to at least the 1700s and the first granite was probably quarried in Scotland near Aberdeen. Today granite for press rolls is quarried primarily in two places; Barre, Vermont and Kuru, Finland. Both granites are quite similar in appearance and mineral composition. Press roll bodies have been quarried in all sizes up to and including 1700 mm × 10,000 mm length.

Due to the importance of the press roll in modern paper machine operation, the components of the press roll must be understood by the paper mill staff. The intent of this paper is to familiarize mill personnel with the properties of granite and serve as an aid in troubleshooting granite roll problems.

Safety

All applicable safety procedures for working around the wet end of a paper machine must be followed. These include the standard safety precautions for working around moving equipment as well as some specific safety regulations required for the application of granite press rolls. As granite is a relatively poor heat conductor, the granite rolls should be heated and cooled slowly to avoid high thermal stress in the body or the roll. To avoid thermal stress the roll at operating temperature should never be hosed by cold water. A new or reground roll should be heated to machine room temperature before it is installed on the machine to avoid the large temperature difference between the cold roll (in the winter) and the warm sheet. The steam shower should not be directed onto the surface of a granite roll.

Material properties

As stated above, the two granites used to construct press rolls today, Barre and Kuru, are similar in appearance and composition. Both have medium fine grain structure and are gray in color.

On a large scale, granite from both quarries is quite homogeneous but may contain some localized dissimilarity such as streaks or knots. No operational problems have been reported due to this type of abnormality.

The three main minerals comprising granite are quartz, mica, and feldspar. Quartz is the hardest mineral present, followed by feldspar and mica; this combination gives granite its high abrasion resistance and wearing properties. Quartz appears as an almost clear gray crystal, feldspar as white or milky gray, and biotite mica as a black crystal.

Intergranular voids and microcracks within crystals are present in both granites; these are the evidence of residual strain set up in formation and during aging of the stone. The presence of these micro-defects does not affect the structural integrity of the granite roll, although they do have some effect in establishing mechanical properties and in fact may be an important factor in sheet release. The presence of these voids makes the use of stylus type

profilometers for surface roughness measurements difficult, as the stylus picks up the void and gives a falsely high reading. For this reason, great care must be used when utilizing a profilometer to gauge granite roll surface finish.

The crystal size varies slightly roll to roll. No perceptible operational differences have been noticed throughout the grain size range of Barre and Kuru granite that has been used in roll construction. Both Barre and Kuru granite exhibit a high resistance to chemical attack as the minerals present are relatively insoluble. Even when subjected to concentrated acids, only small amounts of calcite (a trace mineral) can be leached from the stone.

Some granite roll bodies exhibit traces of pyrite (FeS_2); this iron-bearing mineral can cause “rust” blotches to form on the roll surface. This has not caused any operational problems.

Granite has relatively low tensile strength, but very high compressive strength. To avoid tensile stress on the granite during roll application, the granite roll is always pre-compressed by a steel central shaft or tension bars. One other important factor is that granite has about half the thermal coefficient of expansion of steel. This property has been linked to several granite roll failures of rolls in which the central steel shaft was in contact with the granite body. In some rolls the steel shaft contacts the granite roll only at the two edges, either directly or via centering rings. Thermal expansion of the metal or its corrosion can cause cracking at the edges of such rolls. For the safe construction no metal part should be in tight contact with the inside wall of the shaft drilled into the granite body.

A broken central shaft is the most common type of granite roll failure. The central shaft of granite roll is under considerable tension. During roll operation this shaft might vibrate like a violin string leading to the development of stress-induced crack. This crack gradually propagates deeper into the shaft and eventually results in a catastrophic roll failure. The engineering mechanics of granite and granite press roll design are beyond the scope of this paper; contact the roll manufacturer for further information.

Granite roll operation and troubleshooting

The following section is intended to be used as a guide to assist mill personnel in the operation and diagnosis of problems associated with granite press rolls.

Granite roll grinding

Three types of grinding tool are currently being used to finish granite rolls. All should be able to produce satisfactory surfaces for papermaking, but they are largely different in their operation as discussed below.

1. Silicon carbide wheel - This is the most common type of grinding tool in use. While not the fastest method, it will produce very good surface finishes. Wheels should be balanced and trued carefully to achieve quality finishes. Typical grit sizes range from 36 to 120, with 80 being one of the best all around choices for both roughing and finishing.
2. Continuous rim diamond wheel - These wheels allow maximum stock removal in the minimum time. Diamond wheels must be balanced and trued with special equipment; because of this, a dedicated set of flanges is required for each wheel to avoid remounting. Many grit sizes are available, with the most commonly used being 180. Because these wheels are able to remove stock very rapidly, they are recommended for rough grinding even when silicon carbide is used to finish. By selecting the proper grit size and utilizing the proper techniques, one diamond wheel can rough and finish-grind in less than half the time of other methods.
3. Belt sanders or “superfinishers” - While the use of this method is not widespread, some mills do use abrasive belt grinders. These machines are the slowest of the devices listed here and should be used only for the smallest stock removal jobs or to improve the finish of rough grinding produced by a coarse wheel of the above types.

Preferred finishes vary from mill to mill, the most common being a smooth or honed finish between 25 and 40 RMS. A few mills report better release with a rougher finish, around 125 RMS. The most important factor is to remove enough material so that no damaged crystals remain; this requires grinding below the deepest pit or score lines. In rolls that do not exhibit surface damage from operation, it may be necessary only to restore the profile, and thus only slight stock removal would be required. A common factor in reports of rapid pitting is low stock removal at re-grind; if damaged material is left behind, rapid pitting will result. If the roll life between regrinds has shortened or was better the first time in the machine, removal amounts should be checked.