Production of Granitic Press Rollers in Finland

54

Arto Peltola, Olavi Selonen, and Paavo Härmä

Abstract

The use of granite as material for press rolls in paper machines started in the late 19th century. In Kuru, Finland granitic press rolls were produced from the 1930s until 2008. The suitability of the Kuru grey granite as material for press rolls was defined by its durability, mineral composition, homogeneity, and grain size as well as by the good extractability of the granite. The production of granitic press rolls in Finland developed into a highly specialized industrial process in many phases including: 1. quarrying of the stone block, 2. sawing of the roll, 3. preparation of the ends of the roll, 4. installation of the axis into the roll, 5. pre-compression of the roll, and finally 6. balancing, grinding, and polishing of the roll.

Keywords

Granite • Press roll • Paper machine • Kuru • Finland

54.1 Introduction

The use of granite as material for paper machine press rolls dates back to the late 19th century when it was discovered that granite is a suitable material for that purpose. Granite has excellent sheet release properties when the paper web passes through the rolls in the press section of a paper machine. Initially, the stones for the rolls were quarried and manufactured in Aberdeen, Scotland but due to heightened quality demands for the material only granite from Finland (Kuru) and from US (Barre, Vermont) were used for the production of the rolls.

During the recent years we have carried out geological studies and exploration on natural stone deposits in the Kuru district (Härmä et al. 2006; Nyman 2007; Selonen et al. 2012). In this paper we describe a special industrial use for the grey granite from Kuru.

54.2 Granite as Material for Press Rolls

Granite can be used as material for press rolls in the press section of a paper machine where the paper sheet touches the roll surface for the first time. In the press section the wet fiber web passes between large rolls under high pressure to squeeze out residual water. Then the wet paper sheet will be drawn from the roll surface for further transport through the paper machine.

The use of granite is based on its excellent sheet release properties (Peltola et al. 2012). The surface properties of granite are such that the sheet will be tightly attached to the polished surface of the granitic press roll and subsequently will be released from the roll cleanly without breaking up. This is because the surface of granite is uneven in micro-scale. It is composed of minerals with different crystalline forms and hydrophilic properties. The small scale unevenness of the surface affects the variations of adhesion and

A. Peltola (✉)
Department of Geography and Geology, University of Turku, Turku, Finland
e-mail: arto.peltola@utu.fi

O. Selonen
Department of Natural Sciences, Geology and Mineralogy, Åbo Akademi University, Turku, Finland
e-mail: olavi.selonen@abo.fi

P. Härmä
Geological Survey of Finland, Espoo, Finland
e-mail: paavo.harma@gtk.fi

G. Lollino et al. (eds.), *Engineering Geology for Society and Territory – Volume 5*,
DOI: 10.1007/978-3-319-09048-1_54,

thickness of the water film between the roll surface and the paper sheet, leading to a good sheet release. Furthermore, granite is very resistant against chemical corrosion and ageing. It will not change its form in compression and its properties are not dependent on temperature (20–120 °C).

To be suited for production of press rolls the granite has very strict quality requirements. Granite should be homogeneous, very sound, free of micro cracks and resistant to strong wear (Peltola et al. 2012). The properties should be equal in all directions, and the texture should be small or medium-grained as well as equal-grained. No minerals prone to weathering (e.g. carbonates or sulphides) or break down (e.g. clusters of micas) are allowed. At the quarry the extractability of the granite should allow quarrying of long and relatively thin blocks.

Because of the increased production speed of the paper machines and a few lethal accidents with the granite rolls in 1980s, new coating materials for the rolls were developed (Peltola et al. 2012). Today, mostly ceramic coatings are used. In these coatings, the good sheet release properties of granite can be combined with safety in operation. Today, only one company in the world (Barre, Vermont) produces sporadic granite press rolls by order when necessary. Granite press rolls are still used in some special paper machines (e.g. cigarette paper) because of granite's superb sheet release properties.

54.3 The History of Production of Granite Press Rolls in Finland

In Finland the first granite press rolls for paper machine were manufactured before 1914, by the Ab Granit company (Hanko, SW Finland) from the Drottningberg granite. In Kuru, central Finland the production commenced in the 1930s, and became a more active operation from 1960 when the first dressing facility was raised there. Before 1960, the quarried blocks from Kuru were transported to Hanko or Salo, in southwestern Finland, for dressing, which was done with the stone block in a horizontal position.

In 1960 the first dressing tower was built in Kuru near the quarry where the blocks were extracted. In contrast to the earlier horizontal turning, a method was developed where the block standing in a vertical position was dressed by sawing with a cylindrical saw. Later two more vertical dressing towers were erected in the area. At the height of the production, in the 1980's, 60–70 rolls were manufactured annually, which accounted for 55 % of the world production. In Kuru the biggest press roll produced by dressing of a granite block measured 9,650 mm in length, 1,700 mm in diameter, and approx. 70 tons in weight. The total value of the granitic press rolls made in Finland was 200 million FIM per year (2001).

Higher quality demands for paper machines, mainly regarding production speed, gradually diminished the use of granite rolls. The last granite press rolls were produced in Kuru during the summer of 2008.

54.4 The Kuru Grey Granite

The Kuru granite batholith is a layered intrusion composed of roughly subhorizontal intrusive sheets of grey granites followed upwards by a zone of red granite and topped by gabbros mingling with the red granite (Selonen et al. 2012).

The Kuru grey granite shows a distinct grey colour, but has occasional colour differences, from grey and green to pinkish-red and red. The average grain size is 0.3–2 mm. The texture of the grey granite is generally very homogenous, even-grained, massive or weakly foliated. Potassium feldspar, quartz, and plagioclase are the main minerals. The grey granite is microscopically very sound, the only fractures are small micro cracks in quartz grains. The U-Pb zircon age of the grey granite is 1,875 ± 5 Ma.

The grey granite (Kuru Grey) is quarried from several quarries as facing stone for the global market, and (particularly in Japan) as a popular monumental stone (Selonen and Härmä 2003). The most prominent characteristics of the granite at the quarries is the well-developed sheeting. The spacing of the sheeting joints varies between 0.2 and 4 m. The spacing is more intense close to the outcrop surface and thickens downwards in topography. The vertical fractures are generally scarce with a spacing of 1–10 m.

The main technical properties of the Kuru Grey include water absorption 0.15 % (EN 13755), apparent density 2,630 kg/m^3 (EN 1936), flexural strength 18.6 MPa (EN 12372), frost resistance +8.6 % (EN 12371), compressive strength 225 MPa (EN 1926), abrasion resistance 18 mm (EN 14157), and breaking load at dowel hole 3450 N (EN 13364). These values indicate high durability and resistance to wear.

The good properties of the Kuru grey granite as material for the press rolls were defined by its durability, mineral composition, homogeneity, and grain size as well as by the good extractability of the granite. The granite had a silicate mineral composition with few soft minerals and no sulfides, contributing, together with the fine grain size, the microscopic soundness, and the homogeneity, to the formation of high durability. Due to the high homogeneity of the granite the durability properties were equal in all directions in the stone.

Fig. 54.1 A quarried block ready for dressing. *Photo* Olavi Selonen (1992)

Furthermore, the mineral composition with high quartz content gave the stone good ability to accept polishing. The well-developed sheeting at the quarry made it easy to extract suitable blocks for production of the rolls.

54.5 Production Process for the Granite Press Rolls in Finland

The production of granite press rolls in Kuru was at that time developed into a highly specialized industrial process with several stages (Peltola et al. 2012).

The first stage in the production process was the quarrying of the stone block using the well-developed sheeting in the extraction. The spacing of horizontal fractures determined the height of the block. The back side of the block was released by drilling and blasting, and the ends of the block were cut by jet-flame burning. The splitting of the loosened block was done by drilling and wedging. The biggest blocks measured 1.8 × 1.8 × 10 m (100–120 tons) (Fig. 54.1).

The quarried block was then transported to the dressing tower where the block was set in a vertical position for dressing (Fig. 54.2a and b). The outer surface of the roll was formed by sawing with a rotating cylindrical saw made of ordinary steel pipe (Fig. 54.3a and b) with the aid of steel abrasive and water. Both steel shots and steel grits were used. The sawing speed was 70 cm/8 h, with an accuracy of sawing of ±2 mm. After finishing the outer surface, the hole for the axis was sawed half way through the roll. The roll was lifted out from the dressing tower and the lower end of the roll was cut by drilling and wedging. The roll was then turned around and put back to the dressing tower and the sawing of a hole for the axis was finished. After this phase, the roll was a hollow cylindrical piece of stone, the ends of

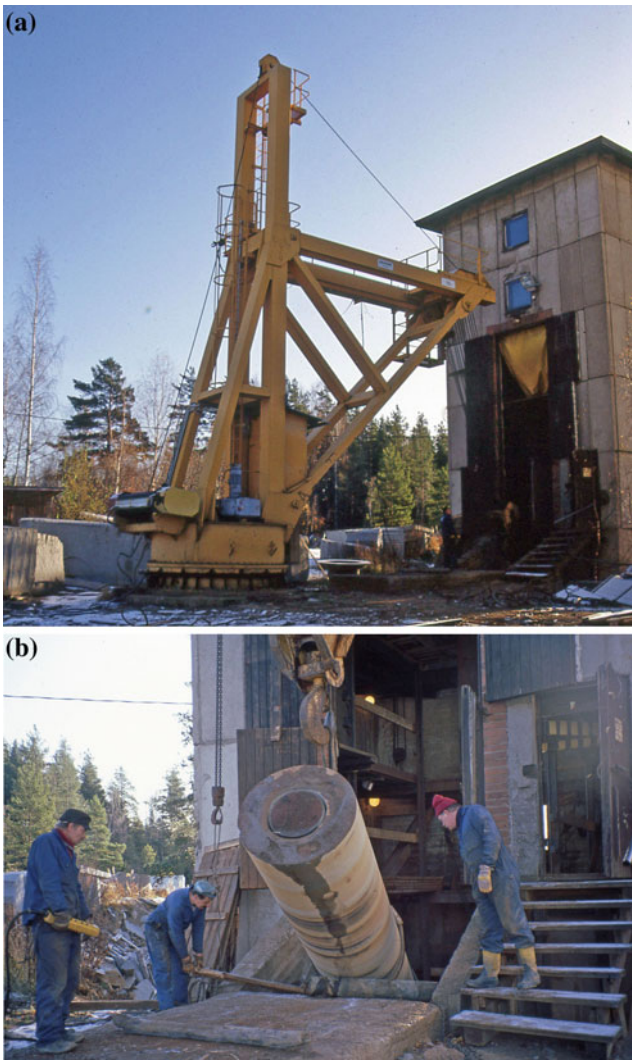

Fig. 54.2 The block was set in an upright position for sawing in a dressing tower. *Photos* Arto Peltola (1993)

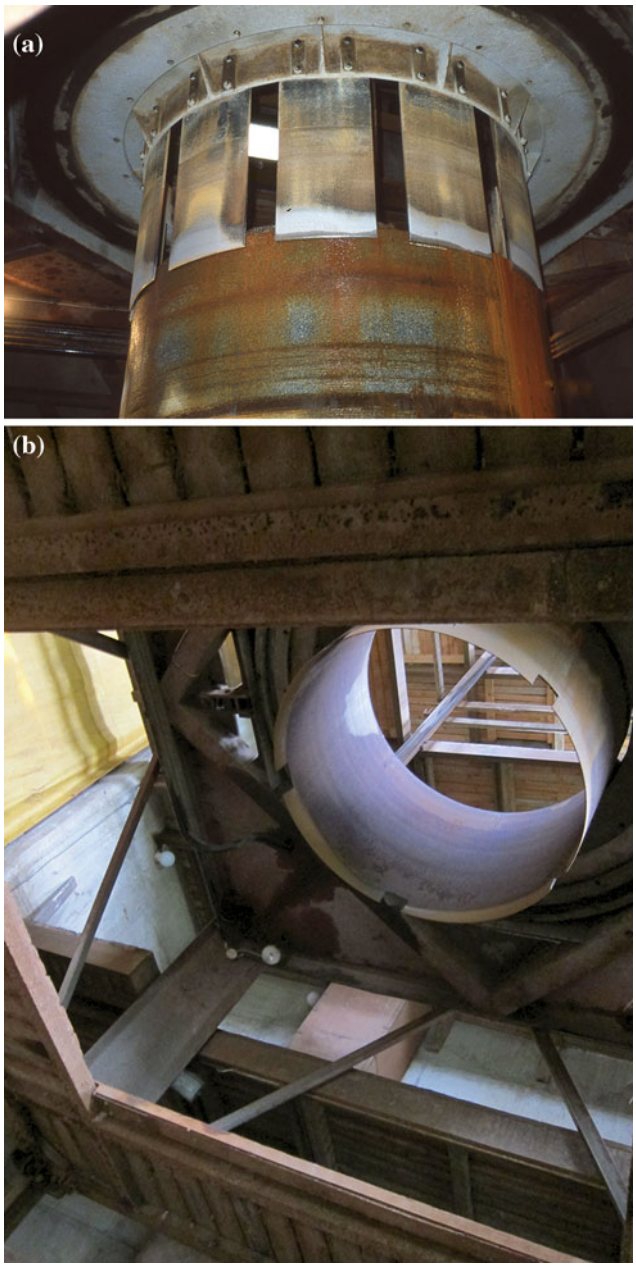

Fig. 54.3 The roll was sawed vertically with a rotating cylindrical saw. *Photos* Roger Aapola (*left* 1987) and Paavo Härmä (*right* 2012)

which had to be prepared according to the demands of the customer. The roll was first cut by wire saw, then the final preparation of the ends was done by an automatic grinding machine, manufactured for this purpose, and equipped with diamond and silicon carbide tools.

Fig. 54.4 Granite rolls ready for export. *Photo* Näsi Granit Oy (1993)

After these stages (Fig. 54.4) the roll was transported from Kuru to the paper machine manufacturer, where a steel axis (Valmet-type roll) or several steel rods (Voith-type roll) was installed. At the paper machine factory, all the large rolls were pre-compressed along the long axis of the roll in order to prevent tensile load in the granitic mantle. The last phases of the production process were balancing and grinding of the roll. The grinding was done to the depth of 6–10 mm after which the surface was polished; the final surface roughness (Ra) of a new Valmet granite roll was max 1.6 μm.

Acknowledgments Prof. Carl Ehlers (Åbo Akademi University) and an anonymous reviewer critically read the manuscript which is highly appreciated.

References

Härmä P, Karttunen K, Nurmi H, Nyholm T, Sipilä P, Vuokko J (2006) Natural stone exploration project in the Tampere region 2001–2005. Geological Survey of Finland, Report KA 33/2006/1, p 24, +8 app. (in Finnish with English summary)

Nyman R (2007) Geological, geophysical, and structural features of the Kuru batholith. MSc thesis. Åbo Akademi University, Department of geology and mineralogy, Turku, Finland

Peltola A, Selonen O, Härmä P (2012) Production of granite press rolls in Kuru, Finland. Finnish Natural Stone Association. Helsinki, p 32 (In Finnish with English summary)

Selonen O, Härmä P (2003) Stone resources and distribution: Finland. In: Suominen V, Selonen O (eds) Nordic stone. Geological science series. UNESCO publishing, Paris, pp 19–29

Selonen O, Ehlers C, Härmä P, Nyman R (2012) Natural stone deposits in an assemblage of subhorizontal intrusions—The Kuru granite batholith. Bull Geol Soc Finl 84:167–174