HARD-FACING BAY FOR REPAIR OF HYDROPOWER EQUIPMENT PARTS IN COMPANY «SAKENERGOREMONTI»

Yu.M. KUSKOV[1], **I.A. RYABTSEV**[1], **Yu.V. DEMCHENKO**[1], **A.M. DENISENKO**[1], **Z.Z. DZHAVELIDZE**[2], **Kh.N. KBILTSETSKLASHVILI**[2] and **A.A. KHUTSISHVILI**[2]
[1]E.O. Paton Electric Welding Institute, NASU, Kiev, Ukraine
[2]Company «Sakenergoremonti», Tbilisi, Georgia

The experience of establishing a hard-facing bay in company «Sakenergoremonti» is described, and design and technological peculiarities of performing in this bay repair of a shaft of the water turbine of 250 mW capacity are considered.

Keywords: *arc hard-facing, water turbine shaft, hard-facing technology, hard-facing materials, hard-facing equipment*

Hydropower is rather well developed in Georgia which is connected with its geographical position. At present in this country have been operating for a long time more than 20 big hydroelectric power stations of more than 1 mW capacity and dozens of smaller ones, that's why special-purpose units and parts of hydroelectric power stations require for repair or replacement, for example, of shafts and blades of the turbines that are subjected in process of operation to cavitation and hydroabrasive wear and corrosion.

In this work experience of establishment of the hard-facing bay in «Sakenergoremonti» is presented and design and technological peculiarities of performing in this bay repair of a shaft of the water turbine of 250 mW capacity are considered.

Shaft of the Kaplan turbine of mentioned capacity is one of its main units (Figure 1, *a*). It is manufactured from the 20G steel and has diameter 1 m, length 4.5 m and mass about 12 t. In process of operation occurs corrosive, cavitation and hydroabrasive wear of the shaft journal located under the bearings and the glands. Subject to renovation a worn part of the journal is located under internal surface of the bearing, the design of which envisages use of water flow for its lubrication and cooling (Figure 1, *b*).

Up till now the water turbine shafts were mainly renovated using method of shrouding. The shroud is manufactured from sheets of the 12Kh18N10T stain-

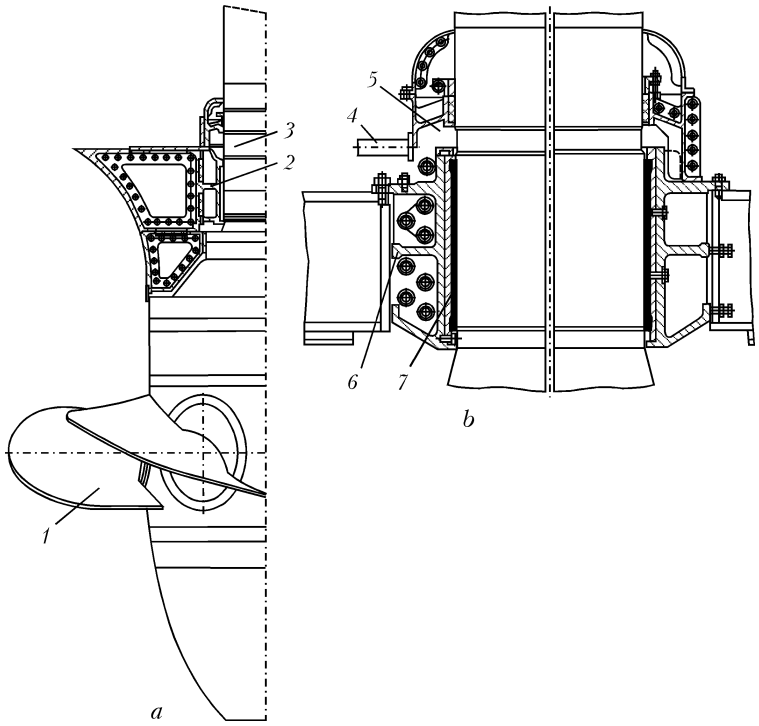

Figure 1. Scheme of shaft of Kaplan water turbine of 250 mW capacity (*a*) and guide bearing (*b*): *1* — impeller; *2* — guide bearing; *3* — turbine shaft; *4* — pipeline for bringing water; *5* — receiving vessel for water; *6* — guide bearing housing; *7* — rubber-coated collar step

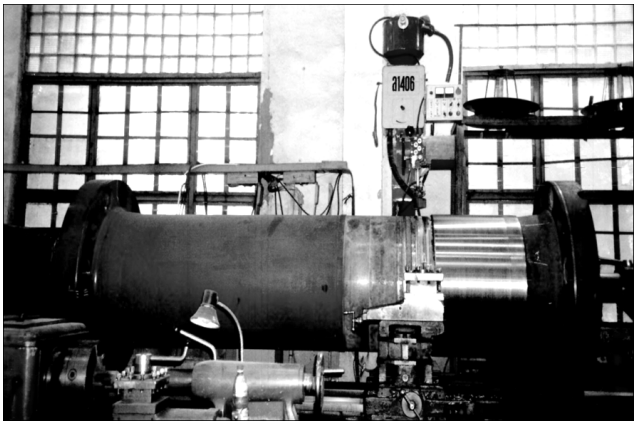

Figure 2. Upgraded installation developed on basis of PT-166 thread-cutting lathe for hard-facing and subsequent machining of water turbine shafts

Figure 3. Appearance of deposited on water turbine shaft corrosion-resistant layer

less steel of 10–12 mm thickness according to a complex technology that includes forge-rolling of the sheets, their cutting, welding, and machining. The time needed for shrouding of the water turbine journal of about 1 m diameter is 2–3 weeks.

Specialists of the E.O. Paton EWI suggested technology for renovation of a worn journal zone using hard-facing. The following technological scheme for renovation of the shaft was developed: visual examination and fault detection; machining for hard-facing; ultrasonic testing; automatic submerged arc hard-facing of a corrosion-resistant layer; turning; ultrasonic testing; grinding.

For hard-facing of the water turbine parts, specialists of STC «E.O. Paton EWI» upgraded at «Sakenergoremonti» enterprise the PT-166 thread-cutting lathe (of the DIP-500) type, and on its basis the hard-facing bay was established. Upgrading consisted in the following: on carriage of the lathe the A1406 hard-facing automatic machine was installed and then tailstock and reduction gear of the lathe were lifted by 160 mm (Figure 2). Electrical scheme of the lathe was supplemented with a frequency converter of the «Lenze» company (Germany) which ensured necessary for hard-facing speed of the water turbine shaft rotation. The VS-600 rectifier was used as a power source. Due to the upgrading it became possible not just to hard-face, but also to machine after hard-facing water turbine shafts of 400–1050 mm diameter, length up to 4500 mm and mass up to 12 t and perform hard-facing of flat surfaces, in particular turbine blades.

In addition to mentioned installation, the bay for repair of the parts comprises a furnace for calcination of the hard-facing materials in which, when it is necessary, heating of the parts before hard-facing and their slowed cooling after it are performed.

Visual examination of the worn water turbine shaft showed that length of the shaft area subject to renovation equaled about 710 mm and depth about 10 mm. On its worn surface defects in the form of cavities, caverns, laminations, etc. were detected. For their removal turning was used after which the remained defects were removed by means of scarfing using abrasive wheels. The machined for hard-facing surface of the shaft was checked for presence of defects using ultrasonic testing.

After machining diameter of the shaft equaled 1000 mm, and nominal diameter of the renovated shaft in this area was 1020 mm. At significant wear of the shaft first deposition of the sub-layer was performed using solid wire of the Sv-08 type and AN-348 flux (diameter of the shaft with the deposited sub-layer equaled approximately 1018 mm). Then on the installation for hard-facing turning of the deposited surface was performed up to diameter 1010 mm and afterwards ultrasonic testing was carried out.

Due to careful observance of all technological operations and technology of hard-facing defects in the deposited sub-layer did not form. External surface of the deposited layer was well formed, difference of height of the adjacent deposited beads did not exceed 0.5 mm.

Automatic multilayer submerged arc hard-facing using the AN-26P flux of the layer of corrosion-resistant stainless steel was performed with application of the Sv-08Kh20N9G7T wire. Diameter of the shaft after deposition of the corrosion-resistant layer was about 1028 mm (Figure 3).

The deposited surface of the shaft was turned down up to diameter 1020 mm, and then ultrasonic testing was performed. In the basic deposited layer as well as in the sub-layer defects were not detected.

As far as diameter of the shaft journal has strict tolerances, the deposited surface was treated by grinding.

All together on the worn surface of the shaft 320 kg of metal were deposited; general machine time of the hard-facing equaled 60 h. Suggested technology of hard-facing ensures significant saving of time and monetary means in repair of the water turbine parts in comparison with shrouding.

Restored water turbine shaft was shipped to the customer, and it will be installed at Inguri Hydropower Station (Georgia) for exploitation.