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AUTOMATIC ARC SURFACING OF WORKING PATHS OF LIFT GATES OF KANIV NAVIGATION LOCK

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The paper gives the results of development and introduction of the technology of automatic arc surfacing of vertical embedded parts of navigation locks without dismantling them in the case of repair of rails of working paths of lift gates in the Kaniv navigation lock. 2 Ref., 8 Figures.

Keywords: navigation locks; lift gates, working path rails, automatic arc surfacing

Geographic position of Ukraine promotes development of its transportation potential, integration into the European transportation system, primarily as a country that takes a special place in providing transit cargo transportation with the most rational option for implementing West-East transport flows.

Four out of nine European transport corridors pass through the territory of Ukraine. The most important for inland water transport is corridor No.9 which connects the ports of White and Baltic Seas with those of Black Sea-Mediterranean basin.

Inland navigable river routes of Ukraine pass mainly through the waters of the Dnipro and Danube and, according to the European agreement on the major inland waterways of international importance they are classified as navigable river routes of the highest category E [1].

There are six shipping locks on the Dnieprovskyi cascade: Kyiv, Kaniv, Kremenchug, Dniprodzerzhynsk, ZRHS (Zaporizhzhya region of hydraulic structures) and Kakhovka.

A navigation lock is a hydraulic structure in the navigable and waterways to ensure the passage of vessels from one water basin (pool) to another with different water levels in them. It is limited on two sides by penstocks, located between which is the penstock chamber that allows controlling the water level within its limits. Transfer of ships with the help of a navigation lock is carried out by sequential passage to the penstock chamber after aligning the water level in them. Lock usage is mainly aimed at making navigable the water spaces with different water levels.

Each lock has three main elements:

- waterproof chamber, connecting the upper and lower parts of the channel and having a volume sufficient for containing one or several vessels. Chamber position is fixed, but the water level in it may change;
- gates — metal shields, located at both ends of the chamber, which are used for letting the vessel into and out of the chamber before the beginning of locking and seal the chamber during locking.
- water supplying device, designed for filling or draining the chamber. A flat panel penstock is usually used as such a device. Transfer pumps can be used in large locks.

Kaniv shipping lock (Figure 1) is located at 727 river kilometre of the Dnipro river. The lock design was developed by Ukrainian Department of S.Ya. Zhuk Institute with the participation of SDB «Zaporizhhidroproekt», SDB «Lenhidroproekt» and «Ukrhidrorichtrans» Institute. The lock construction was carried out by the following trusts and associations: «Dniprobud», «Hidromontazh», «Hidrospetsbud», «Hidroelektromontazh», and «Spetshidroenergomontazh».

The lock was put into operation on 22.07.1972 by locking «T.G. Shevchenko» motor ship. The navigation chamber is 270 m long, 18 m wide, and design head is 12.75 m. Upper lock head is fitted with emergency flat gates and work lift gates The lower head is fitted with work two-leaf gates, repair gates and penstocks. All the technological equipment of the lock

Figure 1. Kaniv navigation lock

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Figure 2. Lift gates of Kaniv navigation lock

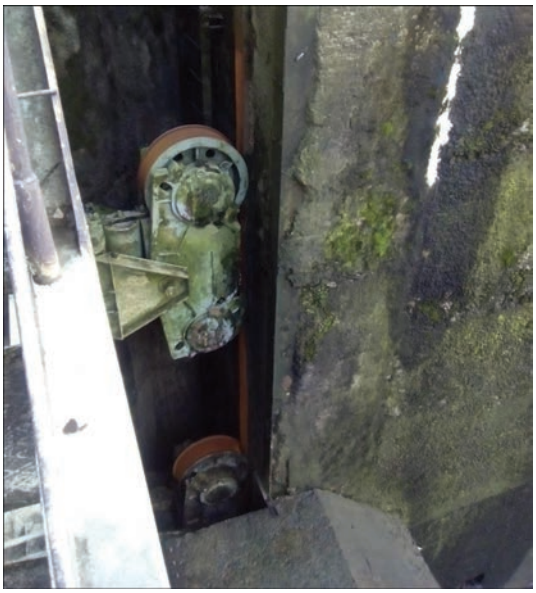

Figure 3. Support carriage of lift gates in Kaniv navigation lock

work gates and penstocks is activated by volumetric hydraulic drives.

From the beginning of operation the lock performed 200470 lockings, with 477545 ships passing through it, i.e. the average monthly number of ships that have passed through the lock during the last year is equal to 97, while the design value is 34 (data as of 2017) [2].

In November, 2017 the Kaniv navigation lock was closed for internavigation repair to perform unique oper-

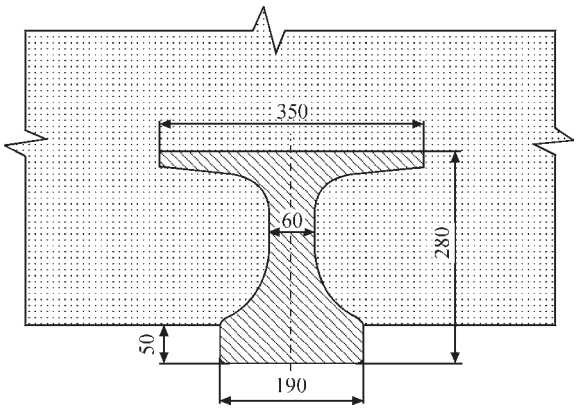

Figure 4. Cross-section of a concreted rail of the working path of lift gates in Kaniv navigation lock (schematic)

Figure 5. Characteristic damage of working path rails of lift gates in Kaniv navigation lock

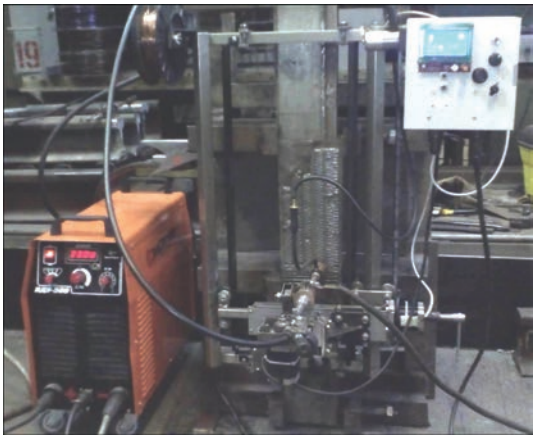

Figure 6. Specialized experimental equipment for automatic arc surfacing of vertical surfaces

ations on replacement of the work lift gates of the lock. The new gates were made by «Ukrhidromekh» Plant (Nova Kakhovka), and dismantling-mounting operations were to be performed by a specialized contactor «Kyivhidromontazh». It was planned to finish the work by May 2018, but because of a lack of funding it was moved to the internavigation period of 2019–2020.

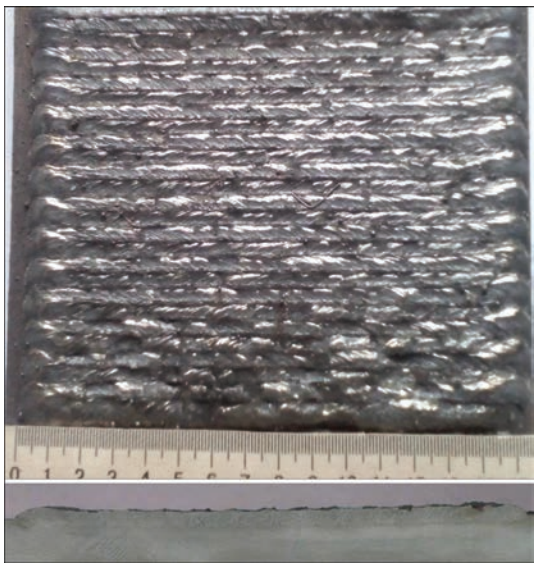

Figure 7. Sample with a deposited region 150 mm wide and its cross-section

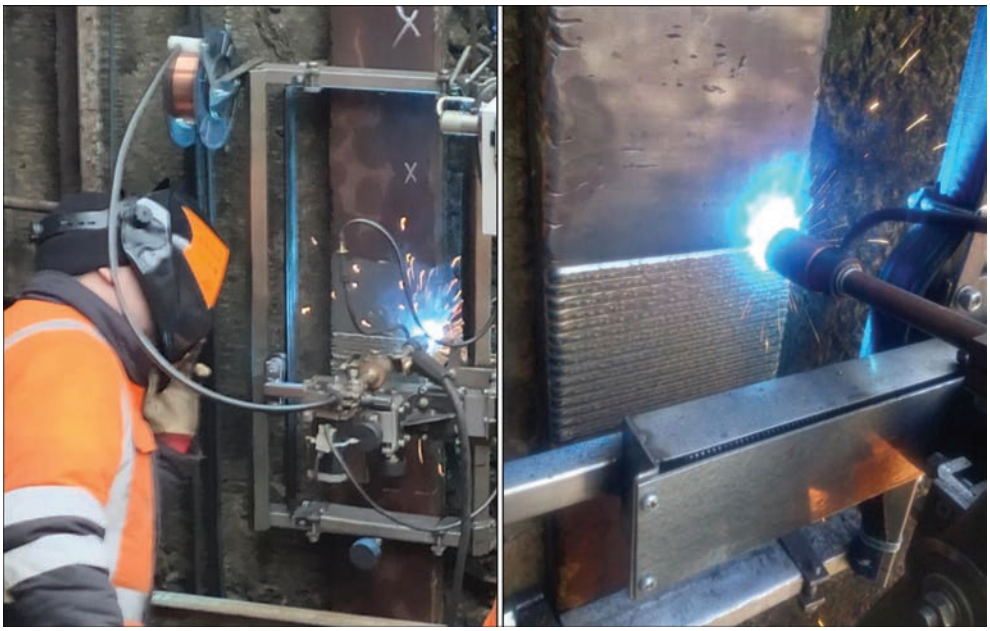

Figure 8. Automatic surfacing of working path rails of lift gates in Kaniv navigation lock

The work lift gates (Figure 2) take the water pressure and transfer it through the support carriage wheels to the embedded parts of the working paths (Figure 3), made in the form of cast rails from steel 45L to GOST 977, that were concreted during their installation in the walls of the guiding grooves of the lift gates (Figure 4). The load on the rails from each gate wheel is equal to 980 kN in the work zone.

Many years of operation resulted in accumulation on the rolling surface of the working path rails of damage in the form of a nonuniform mechanical wear and corrosion pits (Figure 5), the depth of which was equal to 3–5 mm. No cracks in the embedded element base metal or element deformations, not envisaged by design, were detected.

Under Project 8.8 «Development of the technology for repair and restoration of vertical guides of working paths of navigation lock lift gates in the water bodies of the Dniprovskyi basin» of the Purpose-oriented Scientific Research Program «Problems of residual life and safe operation of structures, constructions and machines», PWI developed specialized experimental equipment (Figure 6) for automatic arc surfacing. It was used in the laboratory to optimize the technique and technology of gas-shielded surfacing (CO_2, Ar + + 21 % CO_2 mixture) of vertical surfaces with 1 mm solid wire of Sv-08G2S grade. The above-mentioned equipment allows continuous surfacing of vertical regions of up to 220 mm size across the width and of up to 600 mm in the height, providing the deposited layer thickness within 2.5–4. 0 mm in one pass (Figure 7). Hardness of metal deposited on steel 45 sample is ensured in the range of *HB* 180 – 220, that is on the level of base metal hardness. This development was used at repair of the working paths of lift gates in the Kaniv navigation lock.

After measuring the working paths and their fault detection marking and scraping of the rail sections to be surfaced was performed. Scraping was conducted by electric grinders using steel brushes. The machine was fastened on the respective rail region and its surfacing was performed (Figure 8) across the entire width (190 mm) in the mode that guarantees the required geometrical parameters of the deposited layer. No preheating of the rail was applied, as self-heating of the base metal is ensured during continuous surfacing. After surfacing is over, the machine is moved to the next rail region.

Thus, on the whole, more than eleven linear meters of the right and left rails of the working paths were repaired, which were commissioned in June, 2020, after grinding and replacement of the gates.

The developed technology and equipment can furtheron be used during repair performance in navigation locks and other facilities, where there is a need for surfacing the working surfaces of assemblies and parts of technological equipment without its dismantling, that will allow restoring their serviceability and extending their operating life.

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