L J U B L J A N I C A C O N N E C T S

LIFE10 NAT/SI/142

RECONSTRUCTION OF THE SILL IN ZALOG

Action: C1

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INTRODUCTION

The main objective of action C1 was to reconstruct the sill at Zalog. The sill controls the water level of the Ljubljanica River. In the past, the sill was damaged and, for various reasons, became non-functional, which deteriorated the conditions in the oxbow upstream. If these damages continued to increase, the excessive gaps between the rocks would result in decreased ability or even inability for the fish to migrate upstream.

The restoration of the sill improved the ecological conditions of the Ljubljanica particularly during low flows, when the water level was too low to provide enough hiding places for the water organisms, particularly fish.

The associated beneficiary, Purgator inženiring d.o.o., was in charge of this action, i.e. the selection of subcontractors, and also took care of all the necessary authorisations and permits for the restoration works (under action A2).

The summary of works includes: removal of two trees, the use of 1184 m^3 material for the access road and the construction of the sill, the use of 94 m^3 material for bank protection, and the planting of 18 willow saplings that would improve bank stability and help to preserve the natural appearance after the restoration.

After the restoration, we have monitored the water level in the proximity of the sill and compared it with the water levels prior to the restoration measures. The raising of the water level was observed soon after the execution of works, while the measurements are continuously monitored under action E3.

Problems encountered

The implementation of this action was delayed in view of the timetable envisaged in the Grant Agreement. Local angling clubs have strict rules as to when a certain type of work can be implemented – the implementation depended on the type of disruption caused in the river and the low flows that lasted for almost the entire summer of 2013. The works started in September 2013 and were completed in October 2013.

PROJECT DOCUMENTATION AND TECHNICAL DESIGN

The project documentation and technical design for the restoration works were prepared by Hidrotehnik, Vodnogospodarsko podjetje d.d. Company HIP Plus d.o.o. was selected for execution of works. The works started in September 2013 and were completed in October 2013. The PID documentation (i.e. as-built design, Slovenian: *projekt izvedenih del* – PID) was produced by DK-PROTIM d.o.o. in November 2013.

The restored sill is located on the Ljubljanica river above the Ljubljana–Zidani most railway line. At this location, the Ljubljanica river is a natural asset of national significance. The works were executed according to the technical documentation produced by design company Hidrotehnik d.d. The documentation was approved by the Slovenian Environment Agency, Department of the Middle Sava Area. The nature protection consent issued by the Ministry of Agriculture and environment (now: the Ministry of the Environment) as well as the consent issued by the Fisheries Research Institute of Slovenia were adhered to. No consent by the Institute for the Protection of Cultural Heritage of Slovenia was necessary.

Acquired authorisations and consents

List of acquired authorisations and consents:

- Consents issued by the Fisheries Research Institute of Slovenia to the reconstruction of the sill in Zalog (action C1) of 15 July 2013 and 1 October 2013. The consent was necessary because the area is inhabited by fish populations subject to special protection conditions. For this development, the Fisheries Research Institute of Slovenia issued design conditions, which were taken into account in the design documents for the reconstruction of the stone sill. The consent was issued based on the design conditions considered.
- The water consent issued by the Slovenian Environment Agency for reconstruction works at the sill at Zalog (action C1) of 15 April 2014. The consent was required because of the works that could affect the water regime and status of water. The project conditions issued by the Slovenian Environment Agency had to be met. The project documentation for reconstructing the sill at Zalog had to demonstrate that the interventions would not deteriorate the conditions of waters and water regime.
- Natural protection consent of the Slovenian Environment Agency for reconstruction of the sill at Zalog (action C1) of 13 July 2013. The consent was needed to execute the

construction works in an area which has, under nature protection legislation, a special status. The sill is located in an area under the natural protection status of a valuable natural feature according to the Rules on the Designation and Protection of Valuable Natural Features (Official Gazette of the RS, Nos. 111/04, 70/06, 58/09, and 93/10).

Overview of reconstruction works

This sill is a stone structure (on the figure below it is marked with a red circle) which regulates the water level in the upstream section of the Ljubljanica. The structure plays an important role in preserving the stability of the existing riparian buildings. In the event of its break or any other reason for its disfunctionality (as it was before the reconstruction) the water level upstream would be lowered considerably, which could be devastating for the fish and other water organisms, particularly during low flows. The consequence of sill break would be also the failure of existing bank protections, because the foundations would be “in the air”.

Prior to the restoration the sill was heavily damaged. In some places there were gaps as a consequence of the rocks carried away. The damage was most extensive along the left bank.

The restoration works consisted of filling these gaps on the upstream side of the sill and additional sill stabilisation at the appropriate level by placement of two sets of larger rocks. The rocks were placed individually allowing for larger gaps, so that fish migration was enabled. After the implemented stabilisation of the sill its stability and upstream water level are preserved, which is proven with the measurements as part of ecohydrological monitoring (action E3). Because prior to the reconstruction, the damages were not of such a magnitude as to cause the inability of fish migration upstream the sill (both during low flows and medium flows), the supporting frame itself and the stilling basin were not interfered with in the restoration. The restoration works were implemented in a way to allow for stability of the sill, preserve fish passability, and establish a favourable habitat for fish and other water organisms. Next to the sill we had to stabilise approx. 18 m of the right bank along the sill. The executed works were divided into two segments, i.e. the works for sill stabilisation and rehabilitation works of the damaged right bank.

Figure 1: Location of the sill and regulation areas under action C1

The sill on the upstream side was stabilised using roughly worked stone. Two lines of rocks of a size of 80–100 cm were placed. At the spillway of the sill, the previous condition was retained. The stabilisation of the sill was executed in a total length of 89.40 m. The laying of additional rocks was started behind the previously stable rocks, regardless of the layout (diversified, uneven line). Where possible, the rocks were partially buried in the natural ground. The rocks were placed individually. In-between gaps had to be provided to allow for the migration of fish across the sill. The rocks were not adjusted for height. The gaps between the rocks were filled with the excavated material, i.e. gravel with a size of up to 20 cm. The filling with dredging material and finer stone fractions was necessary to stabilise the structure. In-between the rocks a diverse habitat for water organisms was created with the simultaneous placement of material of different thickness in the gaps. Along the right bank between profiles A and B, where the sill was in solid condition prior to the reconstruction, only one line of rocks had to be placed. Further along two lines of rocks were placed. The restoration works followed the previous routes of fish ways. During the execution, consultations and coordination with local fishermen were underway.

Figure 2: Restoration works for sill stabilisation using a dredger

Prior to the restoration works, the right bank in the sill area was visibly damaged, while during the execution of works additional minor damages occurred on the sill. The bank was rehabilitated in a length of approx. 18 m. The height of the bank in the affected section was around 2.9 m. The bank was profiled in a gradient, i.e. between 1:1.3 and 1:1.15, so that it was adjusted to the previous situation as much as possible and the stability provided. Up to a height of 2 m, the bank was secured with riprap with stones of a size of 50–100 cm, while the rest of the bank was well stabilised and planted by sowing grass and planting willow saplings.

Figure 3: The restored right bank right after the completion of works in October 2013 (left) and in the summer of 2015 (right).

The protection with stone was put in place in a way that allowed for the laying of stone in the designed profile. The individual stones have a secure position and were, in the final stage, anchored so that no riverbank failure could occur due to the instability of the individual rocks. Only rocks of a thickness from 0.5 (at the top) to 1.0 m (in the foundation) were placed. Special attention was placed on the stability of the toe of the riprap. The gaps between the stones of the riprap were filled with the material dredged from the stream and anchored with smaller stones. The gaps in the upper part of the bank were covered in greenery, i.e. with sown grass and planting of willow saplings. The riprap was installed with machinery. The exterior surface of the riprap is rough, while the smooth faces of the stones face inwards. The individual overly large or protruding stones were placed in some places at the toe of the bank. The transitions between the different gradients of the riprap are continuous. The transition between the bank and the riparian zone is also continuous, i.e. not sharp.

The works were executed from the channel, on the upstream side. For the needs of these works an access road in the channel was built, which also served as a coffer dam. The access to the stream from the right bank was provided on a municipal road.

To access the channel, an access road of a width of 4.0 m and a length of 9.0 m was built across the meadow. The topsoil was taken off, felt was placed, and the road was additionally fortified with 16–32 mm ballast. After the completed restoration works at the sill and banks, the road was removed and the original situation restored – covered with humus, levelled, and sown with grass.

The existing riparian vegetation was preserved as far as possible. In the places where vegetation was removed because of the access, the removal of the vegetation was implemented in a way to allow for its original state to restore. The root systems were not interfered with. The individual smaller trees and branches were thinned. The trunks of larger trees were preserved.

An access ramp made of waste stone and tailings in a width of 4.0 m and with an inclination of 1:2.5 was made, and after the completion of the works it was removed and appropriately remediated during the restoration works of the bank.

The transport between profiles A and B was provided along the existing sill, which had to be restored with additional stones. From profile B onwards, we had to build a new access road in the channel. Between profiles B and C, a coffer dam was built in a height of 30 cm, providing at the same time an access road in a width of 3.5−4 m. Tailings and waste stones

of 30−50 cm in a ratio of 30:70 were used for the coffer dam. From profile C onwards the coffer dam was raised to a height of 0.5 m. Using this technology, the road was built until the terrain permitted. In the area where a deep pool was situated behind the sill (cross-sections D and E), the pool was first filled with riprap made of 30–50 cm stone up to the level of the sill, while a coffer dam made of tailings and stones in a height of 0.5 m was built there. After the completion of the works the coffer dam was removed, and the riprap in the pool behind the sill was preserved, as it presents an additional stabilisation of the sill.

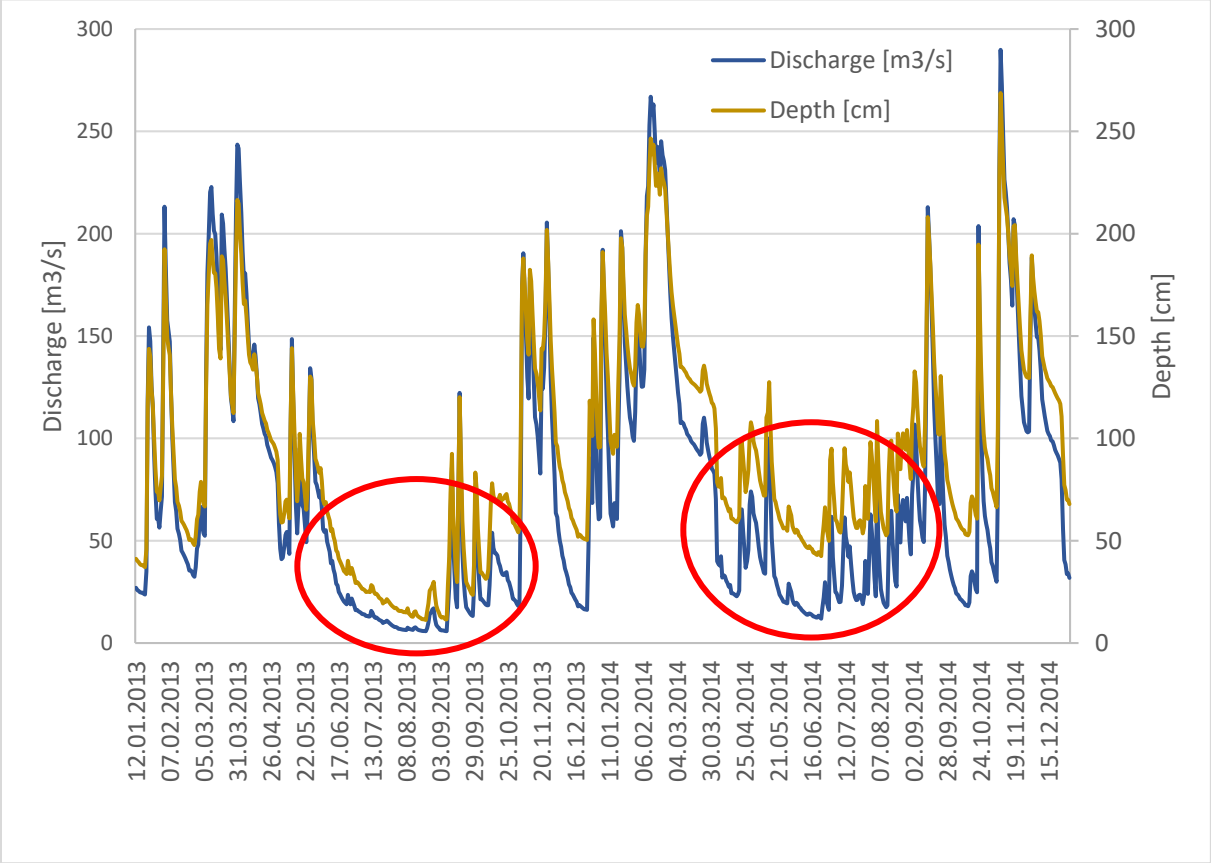
During the execution of the works, the runoff took place along the right edge of the sill between cross-sections A and C. For the needs of water drainage, a pipe in a diameter of 800 mm and a length of 6.0 m was supplied and installed; after the completion of the works, the pipe was dismantled and removed.

Earthworks were performed in a way to minimise the effect of turbidity. A temporary landfill was arranged outside the area of the closed stand of trees and bush vegetation. All technical and other measures for preventing potential river pollution were put in place (seepage of oil and fuel from the dredger into the soil and water channel, etc.). Safe work conditions were maintained.

RESULTS

After the restoration, we have monitored the water level in the proximity of the sill and compared it with the water levels prior to the restoration measures. The raising of the water level was observed soon after the execution of works, while the measurements are continuously monitored under action E3 (Figure below).

We have the data on the discharge only until the end of the 2014, because the Slovenian Environment Agency (ARSO) has not yet published subsequent official data on discharge.



CONCLUSION

After the implemented restoration works, the sill was additionally stabilised, which is of key importance for regulating the Ljubljanica water level. The previously damaged right bank was restored. The lowering of the water level threatened the stability of upstream bank protections, while the existence of fish species was put at risk due to the low flows.

Hydraulic and flood conditions did not change with these measures – the height of the sill and the width of the channel remain the same as before, so flood probability due to the restoration works will neither increase nor decrease.

All the objectives set under this action were achieved. The success of this action is tested by continuous ecohydrological monitoring in the proximity of the sill (action E3). Temperature and water levels are recorded, and dissolved oxygen content readings are taken in the oxbow upstream the sill.