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ASSESSMENT OF TECHNICAL STATE AND DESIGN OF RECONSTRUCTION OF THE SMALL BRIDGE OF THE SLOVINSKY SYSTEM

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Abstract. In the 1950s and 1960s of the 20th century a lot of one- and two-span bridges with a span of 4-6 m were built on public roads on the territory of the former USSR. The paper describes the features of the design and construction of small four-hinged reinforced concrete bridges on lightweight supports of engineer Slovinsky system.

The experience of surveying small bridges shows that in the context of a limited funding, compared to other types of bridges, maintenance and operation of these bridges does not get enough attention. There are relatively low material losses from their destruction and it is possible to restore them fairly easily. Therefore, many of them have a large number of defects and are in a poor physical condition.

The purpose of the work is to draw attention of owners to the problems of small bridges using a specific example, as well as to present effective constructive solutions for the reconstruction of a small four-hinge bridge. These design solutions are developed on the basis of the research and development in Lviv National Polytechnic University and include the use of a reinforced concrete cover slab. The slab has been frequently used in other bridge reconstruction projects and proved its technical and economic efficiency in practice.

The article gives characteristics of the bridge, the technical state of its structures, the main defects and damages, as well as the characteristics of the stream and its influence on the condition of the bridge.

The design solutions for widening and strengthening the small bridge of the Slovinsky system can provide operational performance and consumer properties in accordance with the requirements of the current design standards for new bridges. These standards are able to ensure the service life of the reconstructed bridge.

Keywords: reinforced concrete bridge, Slovinsky system, reconstruction.

Introduction. The study focuses on the bridge located in the village of Goshiv, Bolekhiv City Council of Ivano-Frankivsk region at km. 0 + 074 on the Horynia-Bolekhiv public highway which is of local significance. By the structural design, it belongs to a special type of reinforced concrete slab four-hinged bridges with lightweight substructure. This type was introduced in 1948 by M.O. Slovinsky and was named after him: "small reinforced concrete four-hinged bridge with lightweight structure by engineer M.O. Slovinsky system" [13]. The first standard designs of such bridges with spans of 4-6 m were developed by the author together with Ukrdortrans Research Institute and introduced into construction from 1950-1951. The bridge structures were designed for normalized moving temporary loads H-10 and NG 60. Later in 1967, Design Institute "Soyuzdorproekt" developed a standard design for these bridges for augmented normalized vertical moving loads: vehicular H-30 and wheel load NK-80 according to the construction norms SN 200-62. (Technical conditions for the design of railway, road, and city bridges and pipes. M .: Transdorizdat, 1962).

As for traditional schemes of small bridges, their slabs rest on massive stands, i.e. sustaining walls which are able to resist the lateral earth pressure. Unlike these schemes, the main design features of the bridges include lightweight structure in the form of flat thin monolithic either precast concrete or reinforced concrete vertical walls which function not as sustaining walls, but as a free-support beam system on two buttress piers. The system is affected by the horizontal load from soil pressure (with temporary vertical load on the buttress piers on the shifting prism), load from the structure`s own weight and temporary load on the span structure. At the top, the system is supported by the most rigid slab span structure, fastened to the walls with metal drift bolts. And at the bottom, it is supported by special reinforced concrete struts, hinged to the edges of the foundations. Thus, when providing articulate upper and lower support, the whole system of a single-span bridge is transformed into a four-hinged geometrically variable system (static scheme). Its resistance to horizontal shift is provided only by the embankments on both sides of the bridge which clamp its four-hinged system. Therefore, a prerequisite for the construction of bridges is a particularly careful soil backfilling behind the buttresses, the compacted array of which should create a kind of elastic environment which ensures clamping of the four-hinged system in the soil of the embankment approaches.

Due to the presence of upper and lower buttress piers, horizontal loads are not transferred to the base soils through the soles of the foundations, but are accepted by the soil of the embankment behind the walls of the shore supports. The foundations transmit only vertical pressure to the ground, which greatly facilitates the design of shore buttress piers, so they save up to 50% in general compared to bridges with traditional types of supports in the form of stands with back walls or sloping wings.

Analysis of recent research and publications. Technology of precast concrete elements and construction technology became widespread at that time due to the presence of standard projects and exceptional simplicity of the design solutions. They were considered to be one of the most progressive, promising, and effective designs of the first precast small bridges. As a matter of fact, this type of a small bridge by M.O. Slovinsky is given as an example of effective "modern" design solutions for prefabricated reinforced concrete small bridges in almost all textbooks and manuals on reinforced concrete bridges of the editions of that time [2, 3, 8-11].

Most of these bridges are of single- or two- spans. The bridges with spans of up to 4-6 m have become widespread on public roads of local importance, especially on domestic roads built in the 1960s, 1970s of the last century, numerous reclamation systems at the crossing of main channels which often used natural directed streams and small rivers [6], as well as, in some cases, on changeable watercourses, when culverts could not be used for some reason. Although, they are more efficient than small bridges of any system, including four-hinged M.O. Slovinsky systems.

Inspection of small bridges shows that operation services give little attention to their maintenance and running. Their funding is limited compared to other types of bridges (medium and large). Financial losses from their destruction are relatively low and there is a possibility of simple reconstruction. Therefore, many of them are in decay, have a large number of defects and in general are of poor physical condition.

No due attention is given to the development of design documentation for their repair and reconstruction, as it is considered to be less complicated. Organizations that have no experience or specialists with inappropriate qualifications are often involved. This leads to ineffective, irrational design decisions, and in some cases, to gross errors.

The purpose and task of the work. The primary purpose of the work was to draw attention of the owners to the problems of small bridges. The study also aimed at presenting effective design solutions for the reconstruction of small four-hinged bridges. These design solutions are developed on the basis of research and development in GNDL-88 (Research Laboratory) in Lviv National Polytechnic University and include the use of reinforced concrete slabs. Such slabs have been exploited a lot of times on other bridge reconstruction sites and have substantiated their technical and economic efficiency in practice (according to the implemented projects) [4-7].

The object of the study is a small reinforced concrete bridge of M.O. Slovinsky system. It also includes constructive decisions on its widening and reinforcement in order to improve performance indicators and consumer properties according to the requirements of current standards for new bridge designing. In this case, the design includes providing the term of operation of the reconstructed bridge determined by these standards.

Research methods. Based on the data obtained from additional engineering-geological and hydrological studies, it is necessary to perform calculations on the boundary conditions of the first and second groups to determine strength, stiffness, and crack resistance during the reconstruction of the bridge.

Research results. *Characteristics of the bridge.* It is a small prefabricated slab single-span bridge of M.O. Slovinsky reinforced concrete system (Fig. 1, 2). The clear span is 4.0 m; the clear height between the upper and lower slabs is 2.1 m. The size of the clear headway between the side block elements of the span structure is G-7.6 m without sidewalks. Static scheme of the bridge is a four-hinged closed frame.

a)

b)

Fig. 1. General view of the bridge from the in- (a) and out- (b) openings

The bridge is designed for standardized moving loads according to the norms for bridge design for that period CH 200-62 (1962): vehicular H-30, wheel load NK-80. According to the force impact, the normalized temporary load H-30 is similar to current building code for new bridges DBN B.1.2-15: 2009 (loads and impacts) A 11. It is meant for the bridges on local roads of IV and V categories, including this bridge. So, we can assume that currently the bridge, designed for normalized temporary load H-30 and NK-80, in case of the absence of defects, has sufficient operational load bearing capacity to resist combinations of normalized load A11 and NK-80.

The prefabricated four-hinged bridge consists of shore buttress piers (stands) with straight sloping wings, connected by a slab span structure. The sustaining walls and the sloping wings form a single unit are made of nine vertically placed reinforced concrete slabs with a nominal width of 100 cm and a thickness of 30 cm. At the top, anchor pins connect the wall slabs with the span structure slabs. The lower ends of these slabs are either installed in the grooved mortise of the reinforced concrete foundation pad or they are made L-shaped with the foundation resting directly on the ground.

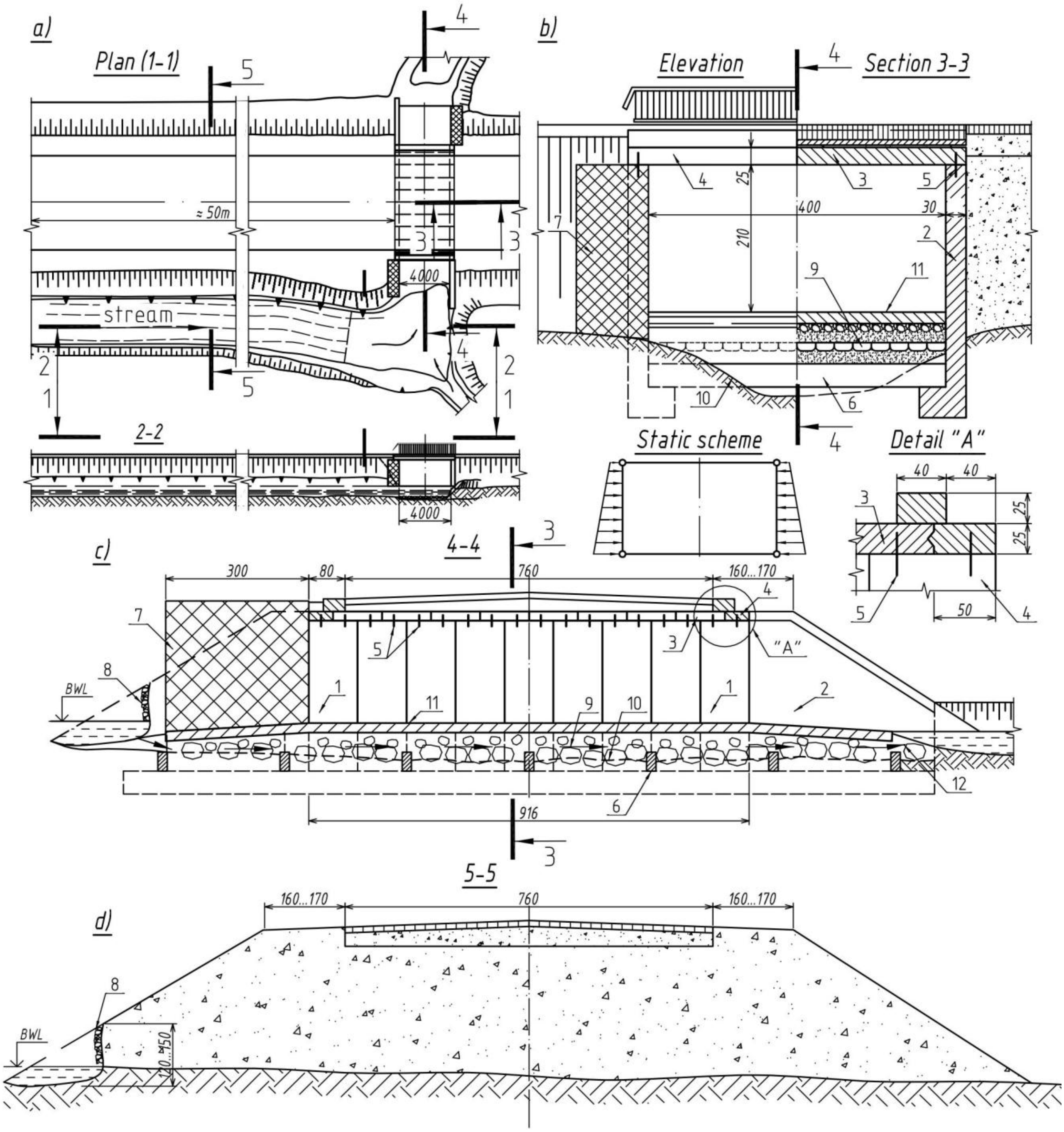

Fig. 2. Situational layout plan (a) and construction of the present bridge (b, c, d):
1 – prefabricated reinforced concrete blocks of sustaining walls; 2 – prefabricated reinforced concrete blocks of straight sloping wings; 3 – prefabricated reinforced concrete slabs of span structure; 4 – monolithic end slabs of span structure; 5 – connecting anchor pins; 6 – lower struts, hinged to the edge of the foundations; 7 – gabions installed to replace the destroyed sloping wings; 8 – waterworn left bank of the stream and the base of the road embankment slope; 9 – probable design of the stream bed under the bridge, reinforced with masonry (paving); 10 – probable zone of the stream bed erosion under the bridge, opening of stops and their destruction; 11 – re-concreted strut slab, a new bottom of the stream bed above the LWL; 12 – filtration and flow of water at LWL under the strut slab within the altitude of the waterworn old streambed

The slabs of the sloping wings are connected at the top by a framing beam, embedded in concrete on site. The lower prefabricated stops are located at the level of the bearing pads batter and are effectively protected by soil-gravel (spalls) backfill of the stream bed within the bridge. It is often reinforced by masonry (paving) to prevent the possible erosion caused by water (Fig. 2, b, c). The wall slabs have vertical grooves on the side surfaces for abutting. They are filled with either cement mortar or fine-grained concrete, forming key connections.

The slab span structure consists of eight prefabricated flat reinforced concrete middle slabs and two monolithic end ones with on-board concrete elements with the railing attached. Currently, only fragments of the railing are preserved. The middle slabs are 460 cm long, 100 cm wide and 25 cm thick. The monolithic end slabs are 50 cm wide. This abutting transmits mainly transverse forces and determines the compatibility of the deflections of the adjacent slabs edges.

Layers of pavement to some extent improve the mutual support of slabs and their joint work across the span. However, they cannot replace the monolithic connection of slabs in the longitudinal seams. Therefore, the calculations assumed the articulation of the slabs in the longitudinal seams, thus accepting extensive distribution of the moving vertical load across the bridge. Slab joints of the span structure are located at the junction with the slab joints of the sustaining walls, so anchor pins on top are installed between these joints (Fig. 2, b, c).

Description of technical state of the bridge structures. The results of the field survey established the operational condition of the bridge and its real consumer properties in comparison with the normalized ones. It revealed the main discrepancies between real and normalized operational requirements, as well as operational defects that significantly affect the general technical state of the bridge and its further normal operation. These discrepancies include:

– absence of sidewalks, protective safety strips, and barrier fencing (Fig. 1, 2), which in the residential area does not fully meet the requirements of pedestrian traffic safety. For this reason, the span structure of the bridge needs to be widened;

– peeling of the concrete protective layer on large areas on virtually unprotected outer surfaces of both monolithic end slabs with the opening and intense corrosion of the working reinforcement with a reduction of its area up to 20% and even rupture of some clamps (Fig. 3, a). The inner layers of concrete of these slabs also have obvious signs of corrosion damage, e.g., cellular loose structure, cracks, which are characteristic signs of concrete casting of poor quality. Because of such damage, these slabs are considered as non-repairable and must be removed. New elements introduced into the span structure during reconstruction can replace their impact on the load-bearing capacity of the span structure. Precast concrete intermediate slabs have no significant defects (Fig. 3, d) and can be used for further operation after the reconstruction of the bridge;

– complete destruction of two straight sloping wings as the result of local erosion of the base (bottom of the stream) under the foundations that are not deep enough. The destruction occurred probably in the parts of the stream bottom with the greatest impact of flood waters. Gabions were collected on the site of the destroyed sloping wings to hold the embankment slopes (Fig. 1, 2). As they perform their protective functions perfectly, they can be left for further use.

One of the two currently available undamaged sloping wings is slightly deviated on the top near the expansion joint which separates it from the sustaining wall (Fig. 3, b). When reconstructing the bridge, this sloping wing must be additionally fixed to the new repair elements and thus prevent its further tilting. Front side slab elements of buttress do not have significant defects and can be used in the future after the bridge reconstruction (Fig. 3, d).

There are other operational defects that need to be eliminated during the reconstruction of the bridge. Thus, poor condition of waterproofing is evidenced by traces of leaching of concrete in the form of white flaky coating on the lower surface of the slab structure (Fig. 3, c). It is the most characteristic sign of water filtration, in particular in longitudinal seams between prefabricated reinforced concrete slabs. Some rods of transverse reinforcement of buttress slabs and span structure (Fig. 3, c) are uncovered because of insufficient protective layer of concrete, which leads to surface corrosion of this reinforcement (Fig. 3, c).

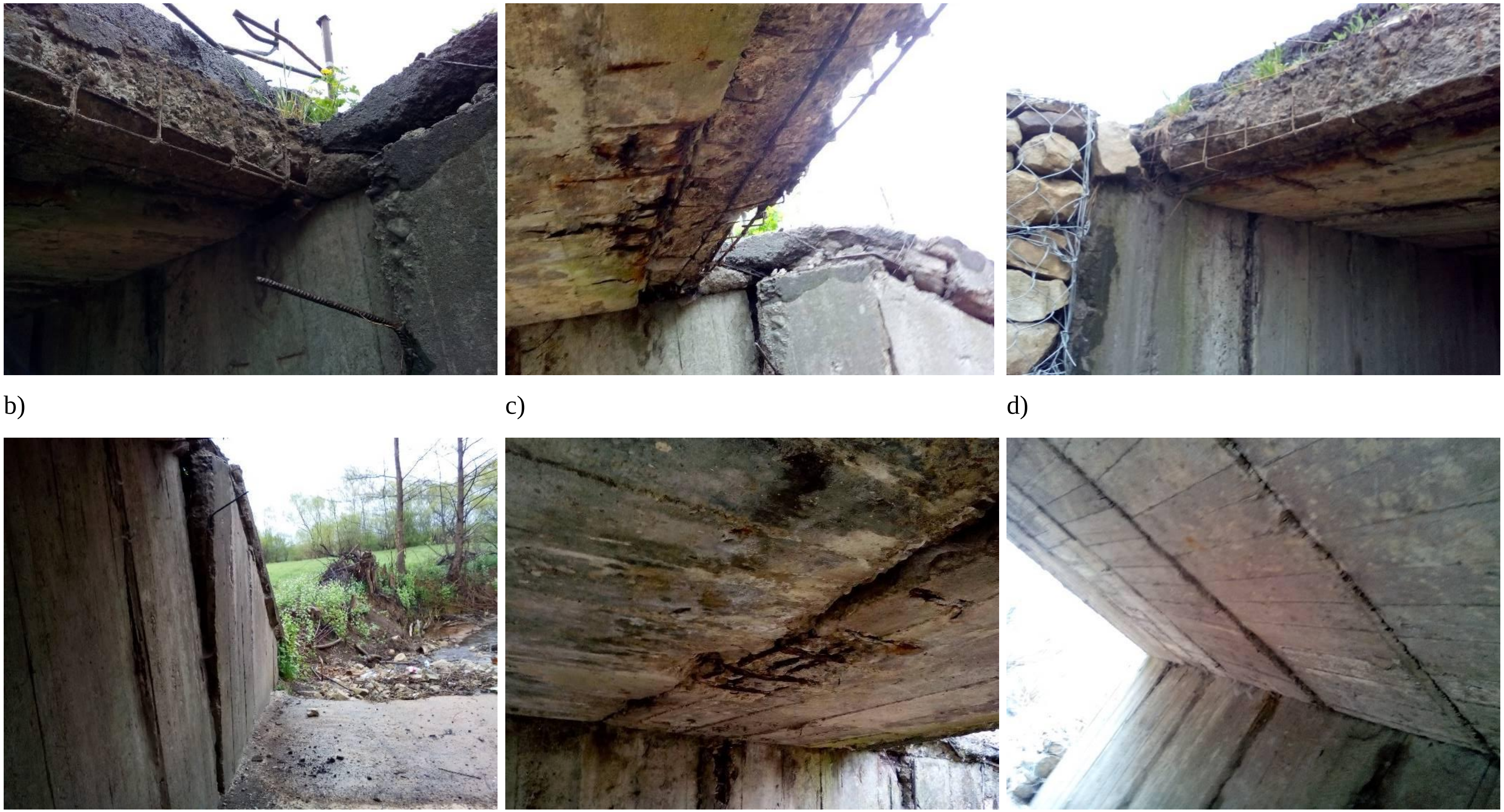

Fig. 3. Typical defects of reinforced concrete structures of the bridge:
a – destruction of monolithic end slabs of span structure; b – tilting the sloping wing; c – sections of peeling of a protective layer and opening of reinforcement of prefabricated slabs of span structure; d – poor quality of monolithic longitudinal seams between the slabs and satisfactory condition of the open surface of the slabs

Some defects appeared during the manufacture of slabs, their transportation to the site and during construction and installation work: spalling of concrete, surface cavities, pinholes, fins, insufficient density of concrete, etc. To ensure the durability of the reconstructed bridge, these defects must be eliminated. All uncovered concrete surfaces of the span structure and buttresses must be protected from the aggressive action of the environment and possible corrosion during further operation with modern high quality materials.

Characteristics of the stream and its influence on the condition of the bridge. A separate group includes possible defects of the bridge and approaches, primarily connected with the orientation of the stream relative to the axis of the bridge and the road close to it. The defects can be caused by the state of the streambed, its geomorphological characteristics, and streambed processes characteristic of piedmont rivers under adverse effects of water flow during floods. In addition, the analysis of the possibility of defects took into account the peculiar and complex nature of the stream as a piedmont river. These peculiarities include: the short duration of floods; large amplitude of water consumption; significant flow velocity; intensive channel processes [1].

The stream belongs to the typical piedmont permanent small watercourses (Fig. 4). Normally, it is characterized by a low-water level (LWL), the depth of which does not exceed 30-50 cm, with a channel width of up to 2.5-3.0 m.

The riverbed is cluttered with the remains of bushes, trees and flow of solid matter. The shores are low, flat, and steep in places after erosion (Fig. 4, c, d, e). At the approach to the bridge, its channel is almost parallel to the road, and the left bank (downstream) is adjacent to the slope of the road embankment (Fig. 4, a). Along the entire length of this area to the bridge entrance, its left bank together with the lower part of the embankment slope is significantly eroded to a total depth of 1.2-1.5 m (Fig. 2, c, d; Fig. 4, a). The process of erosion is not stabilized and occasionally continues. So, this part of the left bank of the stream and the adjacent slope of the embankment needs protection from further erosion.

The streambed turns sharply directly at the bridge entrance (downstream) (Fig. 4, b, c) and crosses the axis of the road almost at right angles (Fig. 2, a; Fig. 4, a). In terms of hydrology, the bridge is located in this unfavourable area. The width of the bridge opening coincides with the width of the stream bed and is 4 m (Fig. 2, a). A sharp turn of the riverbed creates extremely unfavourable conditions for the flow of flood waters and is ideal for erosion of both the riverbed and the banks of the stream. These processes are intense at the turns of the stream, as the curved channel significantly affects the distribution of velocities in the flow. The transverse and longitudinal flows of water that occur at the turns have a helical character. Jets that run into the concave shore go down, wash away the shore and bottom, transferring the erosion products to the opposite shore where they are deposited in the form of sediments [1]. Such nature of the channel process (channel deformations) under the action of flowing water causes destruction of the straight sloping wing of the bridge, located on the inner turn of the channel with the smallest turning radius, as a result of washing the base of shallow foundation.

There is another unfavourable circumstance which did not allow us to inspect the condition of the streambed directly under the bridge and the underground part of the buttresses, in particular the springs. This is a concrete lower slab recently (before the survey) concreted within the area of the bridge opening and sloping wings. As a matter of fact, it is a new reinforced bottom of the stream bed under the bridge (within the width of the bridge and sloping wings) (Fig. 1, 2). Structural working elements of the four-hinged system of the bridge had been left under it. Their condition can be only guessed or deduced from the experience of operation of other similar facilities.

Depending on the intensity of the flood, the erosion process can cover the entire section of the channel under the bridge (Fig. 2, b, c). In this case, its initial (design) attachment 9 will be destroyed and the erosion zone 10 will reach the lower underground struts 6. They will be unearthed and may be damaged or even destroyed by the flow and solid component of water-borne material (river runoff). If the struts 6 freely rest on the edges of the foundations (hinged support), they can be easily knocked out of their position by a strong stream of water. This will inevitably lead to the destruction of the whole bridge because a four hinged system will no longer function under lateral soil pressure after the destruction of struts.

Fig. 4. Streambed character and direction:
a – the adjacency of the left bank (downstream) to the slope of the road embankment and its erosion; b, c – return and entry channel into the bridge opening; d, e – the bed of the stream near and behind the bridge exit

The stream is normally a calm shallow watercourse and does not pose any threat to the road and the bridge (Fig. 4). But judging from the destroyed sloping wings we can assume that during short-term autumn or spring floods channel processes can be quite intense causing the erosion of the riverbed and banks directly near the inlet and outlet openings of the bridge, as well as under the bridge. This can lead to erosion of the embankment of the bottom under the bridge, uncovering the hidden struts 6, their poor condition or even partial destruction.

Therefore, a new spacing slab 11 was later concreted instead of them. Its sole is located on the restored layer of the new boulder-gravel-spall embankment, and the slab itself became the new bottom of the stream within the bridge. Moreover, this bottom was located above the mark of the typical year-round low water level (LWL). In addition, the outer part of the slab from the bridge entrance within the sloping wing and gabion is concreted with a reverse slope (against the current of the stream). So at normal service water level close to LWL, water does not flow from above the plate (streambed under the bridge is dry) (Fig. 1). However, it filters and flows under plate 12, probably through the remnants of waterworn embankment of the old streambed 9. Finding ways to flow in the ground is a natural property of water. But under further long-term operation of the reconstructed bridge, this phenomenon is unacceptable because sooner or later it can lead to a new uncontrolled erosion of the base under the slab and its subsequent destruction. Therefore, the reconstruction of the bridge should include adjusting the streambed and reinforcing from erosion both the banks of the stream and the slope of the embankment.

Description of constructive decisions of bridge reconstruction. The main task of the bridge reconstruction is to bring its performance and consumer properties (i.e. load and discharge capacity, safety and comfort, as well as the standardized service life after the reconstruction) in accordance with the requirements of the current Building Code for new bridges DBN B.2.3-22:2009, according to the regulations of public roads of local significance. The conceptual condition for designing the bridge reconstruction is the maximum possible further use of the existing structures. It can guarantee the minimum cost of the reconstruction.

The present span structure is widened from the size G-7.6 m without sidewalks to the new size G-8 m with sidewalks of 1.5 m at both sides, as well as protective barrier and railings according to the requirements of Building Code DBN B.2.3-14: 2006 and DBN B 1.3-22:2009.

In order to expand the span structure, Research Laboratory GNDL-88 of Lviv Polytechnic National University developed the design of a monolithic reinforced concrete cover slab with cantilever suspensions. These slabs and the existing ones were secured with special anchors [12] to ensure their joint work in the widened span structure (Fig. 5). In this case, the existing monolithic non-repairable end reinforced concrete slabs, 50 cm wide, are removed. The cantilever section of the cover slabs is adjacent directly to the open side surface of the prefabricated end slab, thus, protecting it. Rod anchors A-2 (part "B") also join it.

A similar design of the cover slab has been implemented multiple times during the reconstruction or repair work of bridges with different types of span structures [4-7, 12]. It also showed high efficiency and enabled the possibility of a comprehensive solution of a main task, i.e. widening of the span structure with a simultaneous increase in load and discharge capacity, safety, and comfort of movement.

Cover slab is arranged on top of the existing ones. When necessary, it can be used to reinforce these slabs by lengthening the cross section from above, i.e. jointing the cover slab with the existing ones with loop anchors [12]. This ensures their joint work as part of the extended span structure (Fig. 5, part "A").

The reinforced concrete cover slab is lengthened by 1.5 m. This helps buttress piers to reduce the impact of the active horizontal soil pressure from the vertical temporary load located on the shifting prism. Transverse ribs are arranged at its ends to support the approach slabs. Thus, the vertical temporary load from these end sections of the cover slab as well as from the approach slabs is practically not transmitted directly to the soil of the shifting prism, i.e. the sustaining walls are unloaded from this part of the lateral soil pressure. This reduces bending moments in the sustaining wall like beams on two supports, i.e. it serves as reinforcement of the sustaining walls.

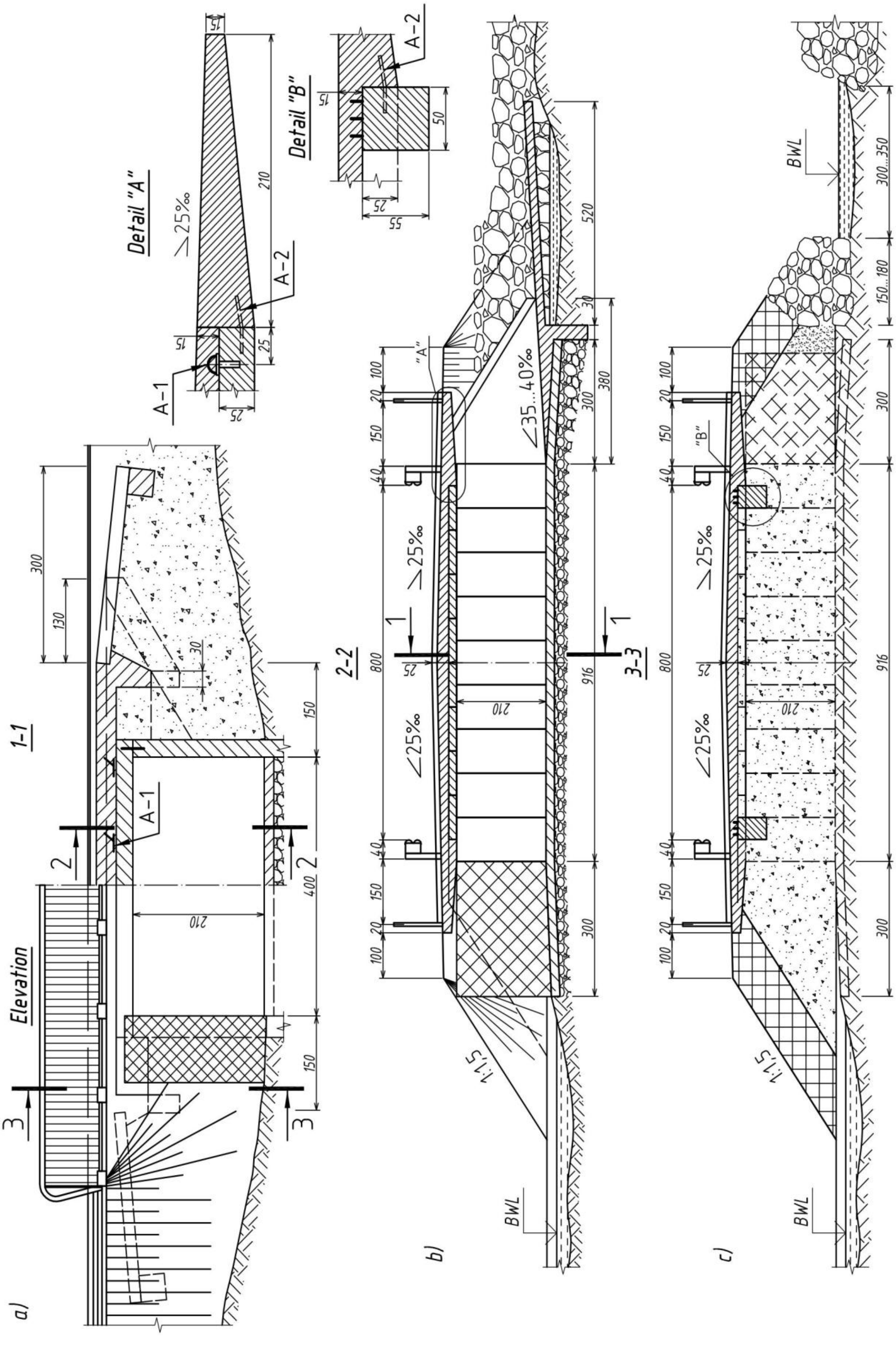

Fig. 5. General view of the bridge after reconstruction

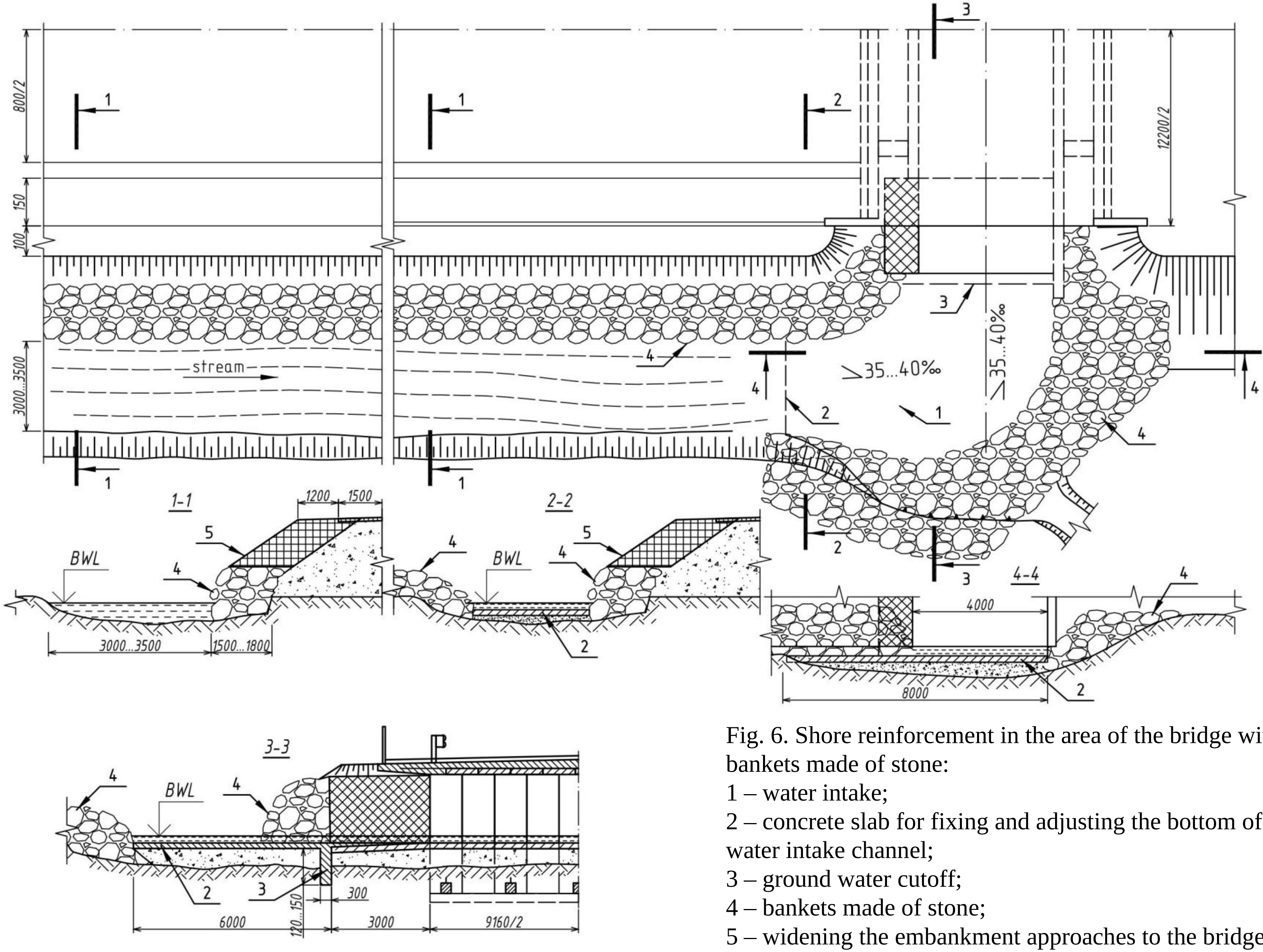

Fig. 6. Shore reinforcement in the area of the bridge with bankets made of stone:
1 – water intake;
2 – concrete slab for fixing and adjusting the bottom of the water intake channel;
3 – ground water cutoff;
4 – bankets made of stone;
5 – widening the embankment approaches to the bridge

Recalculation of the bridge after reconstruction is performed for standard moving temporary loads A15 and NK-100 according to the requirements of current building code for new bridges DBN B.1.2-15:2009, just like for the bridges on the road of the promising third technical category. However according to the existing classification this road currently belongs to the public road of local significance of the fourth technical category. In spite of this, when designing the reconstruction, the norms allow conducting analysis of the engineering structures to reduce the standardized loads A11 and NK-80. That is, in the future, when transferring the road to the highest third technical category in the absence of defects, the bridge will not require additional interventions, and, accordingly, additional expenditures.

To reduce the speed of flood flow in front of the bridge entrance, it is planned to create an extended zone of water intake when the channel under the bridge turns and the bottom of the channel in this zone rises to marks higher than the current mark of the top slab. The bottom of the streambed in this area also should be reinforced with a concrete slab 15-20 cm thick on a compacted boulder-gravel base (Fig. 6).

In addition, the filtration of water can be stopped by blocking aquifer under the slab in the space between the wing wall and the gabion in front of the bridge entrance. This requires arranging ground water cut-off in the form of a concrete wall 25-30 cm thick, deepened into the bottom of the stream by 1.2-1.5 m, i.e. within the probable thickness of the possible filter layer of the soil.

The manual [1] recommends providing strengthening structures such as blankets of large natural stones which are simple to use in the process of construction and further operation. This will help reinforce and protect the banks of the stream and the slope of the embankment of the earthworks approaches in the zone of erosion. Under these specific conditions, if the fractional composition of the rock is observed, the stone blankets are able to ensure the strength and resistance to the destructive effects of flood waters, as well as durability and efficiency.

The blanket of large stones actively resists the wave energy and the flow of the river. The transverse profile of the blankets in all protection areas is of trapezoidal shape in case of erosion-resistant bottom of the stream near the shore and the foot of the embankment slope. The estimated maximum diameter of large stones is dk≥50 cm, weighing 200-250 kg. The following fractional composition of the rock is recommended [1]: the maximum diameter of the rock dk ≥50 cm, (weight of stones 200-250 kg) – content of 60-65%; minimum diameter du d0.04 dk = 2-3 cm, – content 10-15%; intermediate fractions with a relatively uniform distribution – the content of 20-25%.

Stone structures are durable, they are able to withstand the destructive mechanical action of the flow during catastrophic floods, they are resistant to destruction and abrasion by sediments and floating objects in water (stones, trees) and ice. The bumpy or jagged surface of the blanket dramatically reduces the flow velocity near the structure and, and in such a way reduces bottom erosion.

Conclusions:

1. A small reinforced concrete bridge, including eng. M.O. Slovinsky type, which is the focus of this work, occupies a significant place in the bridge infrastructure of the road industry, so due attention should be given to their maintenance and restoration for further operation. And in order to develop design documentation for major repairs or reconstruction, it is important to involve design or research organizations with relevant experience and technological development of bridge reconstruction.

2. The use of reinforced concrete cover slabs in the reconstruction of small bridges allows conducting complex renovation with minimal costs and helps to restore their performance and consumer properties, i.e. load and discharge capacity, safety, and comfort, as well as to ensure standardized service life in accordance with current design norms for new bridges.

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ОЦІНКА ТЕХНІЧНОГО СТАНУ ТА ПРОЕКТУВАННЯ РЕКОНСТРУКЦІЇ МАЛОГО МОСТА СИСТЕМИ М.О. СЛОВІНСЬКОГО

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Анотація. У 50-х, 60-х роках минулого століття на території колишнього СРСР на дорогах загального користування були масово побудовані одно- і двопрольотні мости довжиною прольотів до 4-6 м. Описано особливості обстеження, проектування і будівництва малих чотиришарнірних залізобетонних мостів на полегшених опорах системи інж. Н.А. Словінського.

Досвід обстежень малих мостів свідчить, що в умовах обмеженого фінансування у порівнянні з мостами інших типів (середніх та великих) їх утриманню з боку відповідних служб приділяється недостатня увага при незначних матеріальних втратах від їх руйнувань та можливості простого відновлення. Тому багато з них у значній мірі є запущеними, мають велику кількість дефектів і, загалом, незадовільний фізичний стан.

Мета роботи в першу чергу полягає в тому, щоб на конкретному прикладі залучити увагу експлуатаційних служб до проблеми малих мостів, а також представити ефективні конструктивні рішення реконструкції малого чотиришарнірного мосту, розроблені на базі науково-дослідних та дослідно-конструкторських розробок ГНДЛ-88 НУ «Львівська політехніка» з використанням залізобетонної накладної плити, яка багаторазово застосована на інших мостових реконструйованих об'єктах та на практиці підтверджує свою техніко-економічну ефективність.

Приведена характеристика існуючого моста, описано технічний стан його конструкцій, основні дефекти та пошкодження, а також характеристика струмка та його вплив на стан моста.

Приведені конструктивні рішення розширення та підсилення малого моста системи Н.А. Словінського для забезпечення експлуатаційних показників за вимогами чинних норм проектування нових мостів при забезпеченні терміну експлуатації реконструйованого моста за цими ж нормами.

Ключові слова: залізобетонний міст, система М.О.Словінського, реконструкція.

ОЦЕНКА ТЕХНИЧЕСКОГО СОСТОЯНИЯ И ПРОЕКТИРОВАНИЕ РЕКОНСТРУКЦИИ МАЛОГО МОСТА СИСТЕМЫ Н.А. СЛОВИНСКОГО

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Аннотация. В 50-х, 60-х годах прошлого столетия на территории бывшего СССР на дорогах общего пользования были массово построены одно- и двухпролетные мосты длиной пролетов до 4-6 м. Описаны особенности обследования, проектирования и строительства малых четырехшарнирных железобетонных мостов на облегченных опорах системы инж. Н.А. Словинского.

Опыт обследования малых мостов свидетельствует, что в условиях ограниченного финансирования по сравнению с мостами других типов (средними и большими) их содержанию со стороны эксплуатационных служб уделяется недостаточное внимание, учитывая сравнительно незначительные материальные потери от их разрушения и возможность достаточно простого восстановления. Поэтому многие из них в значительной степени является запущенными, имеют большое количество дефектов и в общем – неудовлетворительное физическое состояние.

Цель работы в первую очередь заключалась в том, чтобы на конкретном примере привлечь внимание владельцев к проблемам малых мостов, а также представить эффективные конструктивные решения реконструкции малого четырехшарнирного моста, разработанные на базе научно-исследовательских и опытно-конструкторских разработок ОНИЛ-88 НУ «Львовская политехника» с использованием железобетонной накладной плиты, которые неоднократно применяли на других мостовых реконструируемых объектах и на практике подтвердили свою технико-экономическую эффективность.

Приведена характеристика существующего моста, описано техническое состояние его конструкций, основные дефекты и повреждения, а также характеристика ручья и его влияние на состояние моста.

Приведенные конструктивные решения уширения и усиления малого моста системы Н.А.Словинского для обеспечения эксплуатационных показателей и потребительских свойств по требованиям действующих норм проектирования новых мостов при обеспечении нормированного этими же нормами срока эксплуатации реконструированного моста.

Ключевые слова: железобетонный мост, система Н.А.Словинского, реконструкция.

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