MODERN TECHNIQUES FOR THE CONSTRUCTION OF MONOLITHIC BRIDGES

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Abstract. *Over recent years, various new techniques and technologies have been used in the construction of bridges. The construction of monolithic structures is one of the well-known and unconventional methods. This article provides practical recommendations on the construction technology of new types of solid axle reinforced concrete (monolithic) bridges and overpasses, which cover the construction, reconstruction, and repair of bridge structures made of monolithic reinforced concrete located on public roads of all categories and climatic zones.*

Keywords: *monolithic bridge, construction technology, superstructure, abutment, special auxiliary structures and devices.*

СОВРЕМЕННЫЕ СПОСОБЫ ТЕХНОЛОГИИ СТРОИТЕЛЬСТВА МОНОЛИТНЫХ МОСТОВ

Аннотация: *В последние годы в строительстве мостов стали применять различные новые техники и технологии. Строительство монолитных конструкций является одним из известных и нетрадиционных методов. В данной статье приведены практические рекомендации по технологии строительства новых типов неразрезных железобетонных (монолитных) мостов и путепроводов, которые распространяются на строительство, реконструкцию и ремонт мостовых сооружений из монолитного железобетона, расположенных на автомобильных дорогах общего пользования всех категорий и климатических зон.*

Ключевые слова: *монолитные мосты, технология строительства, пролетное строения, опора, специальные вспомагательные сооружения и устройства.*

Introduction. At present, in the Uzbek bridge-building, new pages are being opened at an active pace. The construction of monolithic bridges and overpasses is considered an important aspect. Reinforced concrete monolithic bridges are distinguished by their strength, durability, and good performance. New times dictate new requirements in the approach to the construction of transport facilities, so the construction technology also changes. In this regard, designers and builders tend to move to the development of unconventional engineering solutions [1, 2, 7]. It should be noted that monolithic bridges with solid spans are recommended for use in cities due to their high architectural qualities, cost-effectiveness, and strength.

Main part. This article discusses the construction technology of new types of solid axle reinforced concrete (monolithic) bridges and overpasses on the example of a new overpass, which is being implemented on the 1083rd km of the M-39 highway passing through the city of Samarkand. Practical recommendations are given on the technology of construction of new types of solid axle reinforced concrete (monolithic) bridges and overpasses, which apply to the construction, reconstruction, and repair of bridge structures made of monolithic reinforced concrete and located on public roads of all categories and climatic zones.

Before the start of the construction of a road overpass on Dzhurakulov Street at the intersection with the M39 highway in the city of Samarkand, a full range of organizational and preparatory operations should be performed, namely:

− all networks passing the construction site should be removed. For networks that fall into the construction footprint, but are not subject to be moved, measures for their safety must be determined, and all organizational and technological documentation for the construction of the bridge must be agreed with the owners (authorized representatives of the owner) of these communication networks;

− overhead transmission lines passing over the territory of the overpass under construction must be taken out of the construction site for the period of work;

− a bypass road should be constructed and diversion of motor traffic to it should be done;

− a construction site should provide the premises for administrative, industrial, and general services;

− the relocation of the longitudinal axis of the overpass, and the abutment axes should be conducted;

− a technological platform for the work production should be prepared [3, 4].

Technological sequence of works

Works on the ***construction of overpass abutments*** are conducted in the following sequence:

Reinforced concrete piles 14 m long are driven in a row sequence using the RTG RM-20 pile driver with preliminary excavation to a depth of up to 3 meters (for a working row) and drilling of wells to a depth of 5 m (Fig. 1). The work is conducted using excavating machines with 1.83 and 0.9 m^3 buckets. Next, the excavation of the pit to the design marks is carried out and the pile heads are cut with hand-held pneumatic hammers (Figs. 2 - 4). The excavated soil is loaded into tipping lorries and transported to disposal sites in accordance with a specially developed and duly agreed “waste management regulation”.

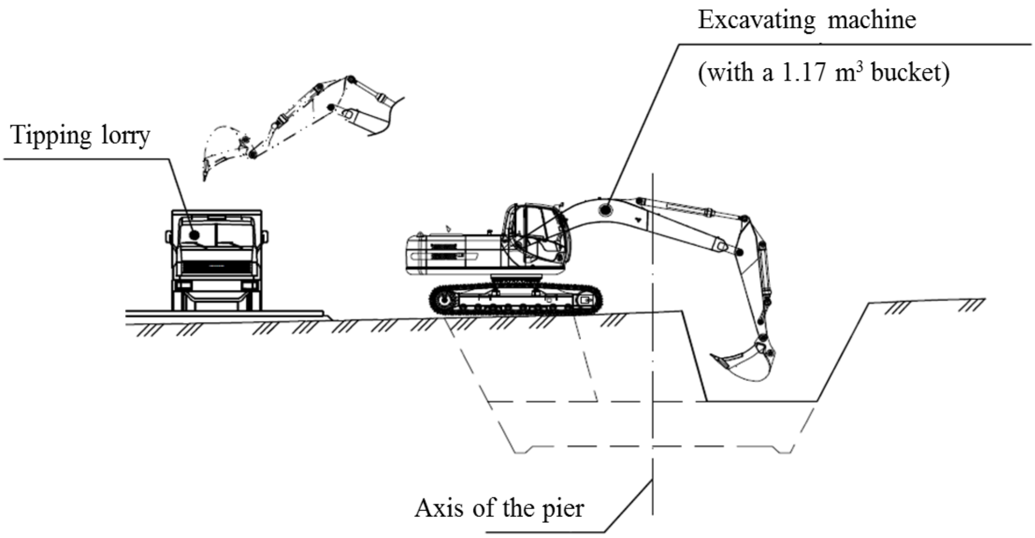

Fig. 1. Stagewise excavation

Water is pumped out of the excavation pit; the pumped water is collected in special settling tanks and, after cleaning, is transported by specialized vehicles to disposal sites.

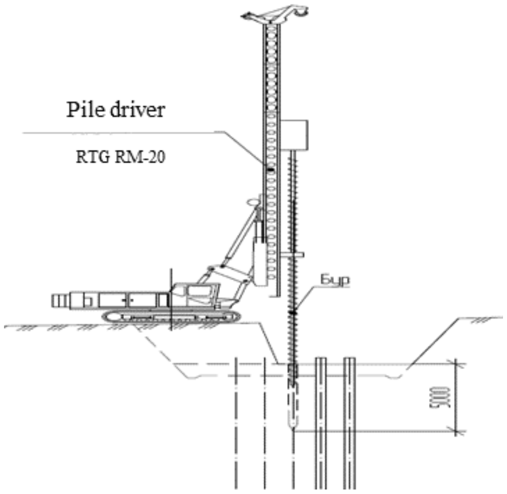

Fig. 2. Borehole devices for pile-driving

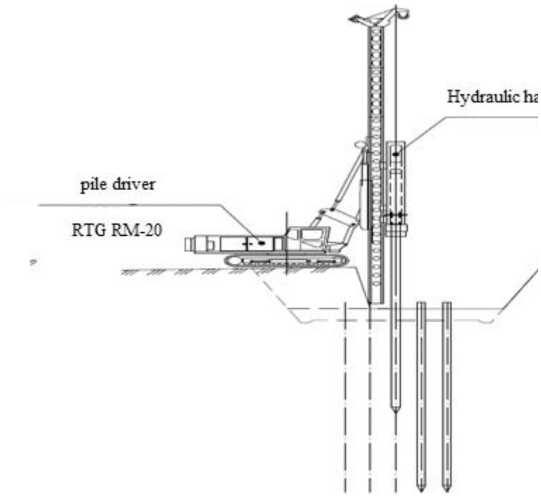

Fig. 3. Pile-driving

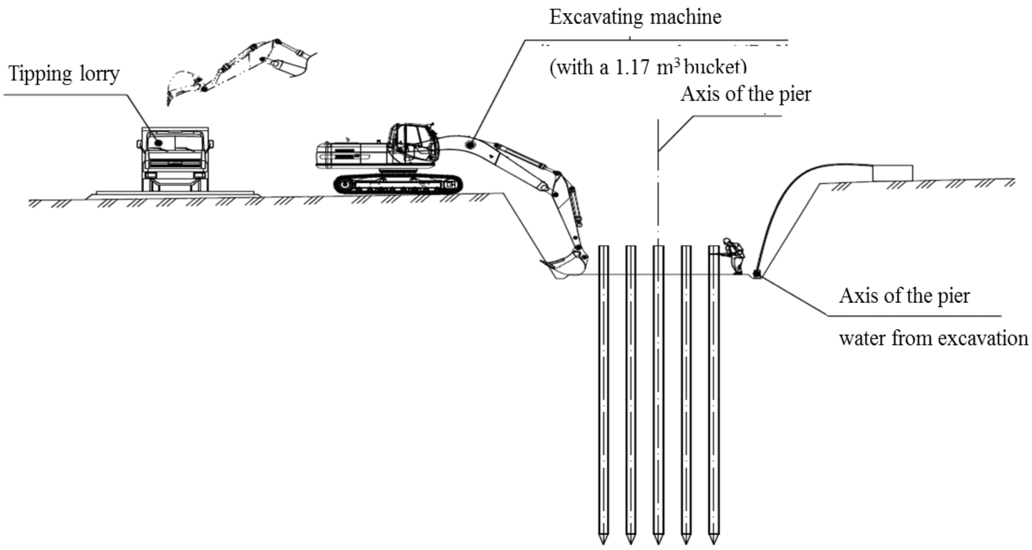

Fig. 4. Development of excavation to design marks, cutting of pile heads

The gravel layer is backfilled under the grillage with pouring cement mortar. The grillage is reinforced with the installation of a system with free lengths into the body of the reinforced concrete part of the abutment [3]. The assembly of wood-metal formwork of the grillage is being installed (Fig. 5).

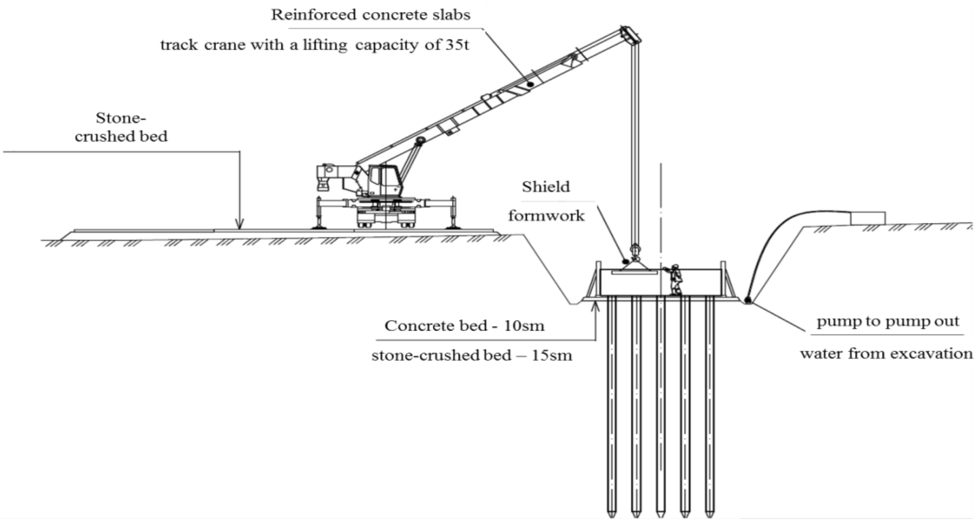

Fig. 5. Construction of the lower part of the grillage

Concreting the grillages of abutments is carried out with truck-mounted concrete pumps. Concrete for monolithic structures is produced at the reinforced concrete fabricating yards of the city of Samarkand and delivered to the construction site in concrete mixer trucks. The supply of reinforcement and formwork of grillages and abutment bodies is carried out by a truck crane with a lifting capacity of 50 tons [4]. Immediately after the completion of the concreting of the monolithic structure, the exposed surfaces are covered with protective envelopes that prevent water evaporation. These envelopes are kept until the concrete strength reaches at least 80% of the design strength. The construction of the grillages of intermediate piers No. 2 and No. 3 is carried out by turns for the lower and upper parts of the grillages (Figs. 6 and 7).

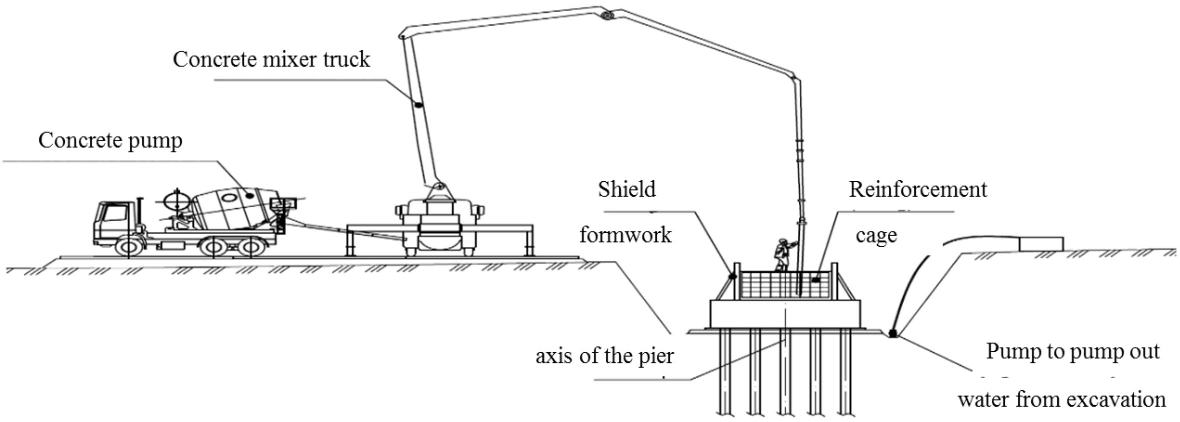

Fig. 6. Construction of the upper part of the grillage

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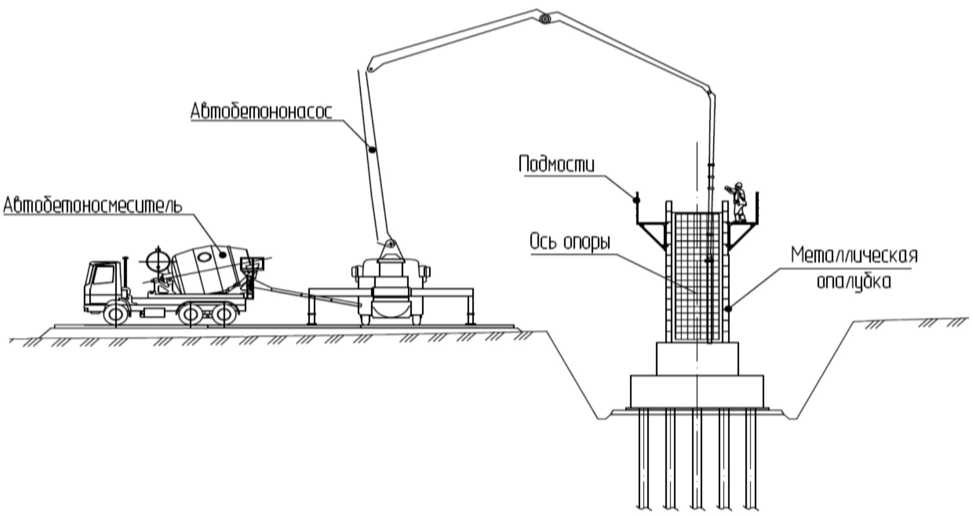


Fig. 7. Construction of the abutment body

After the concrete has gained at least 80% of the design strength, protective envelopes and formwork of the abutment bodies are dismantled, waterproof pargeting is applied and the pits are backfilled using tipping lorries and an excavator with layer-by-layer compaction of soil with hand-held rammers (Fig. 8). For abutments (piers No. 1 and No. 4), concreting the extensions is carried out on solid scaffolds. Reinforcement and wood-metal formwork are delivered using a truck crane with a lifting capacity of 50 tons. Concreting of under-truss platforms is carried out after hardening of concrete for intermediate piers and extensions for abutments.

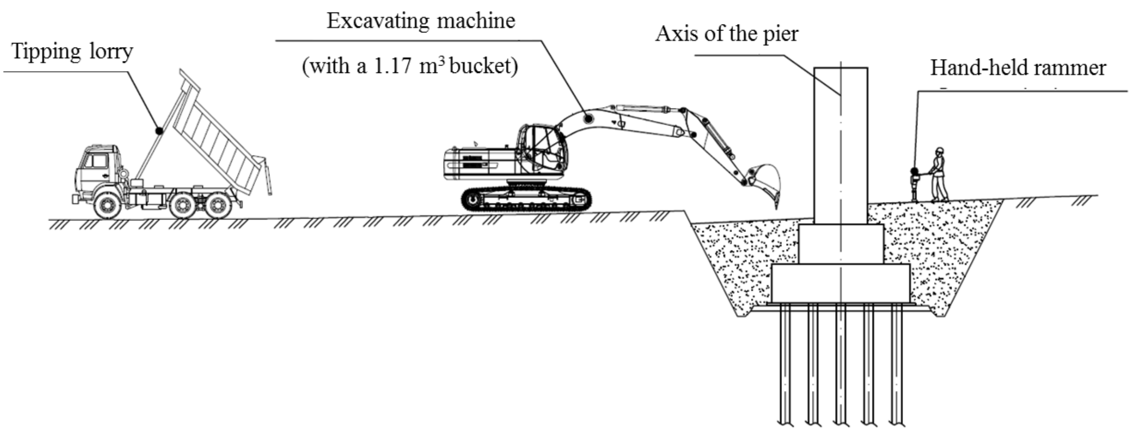
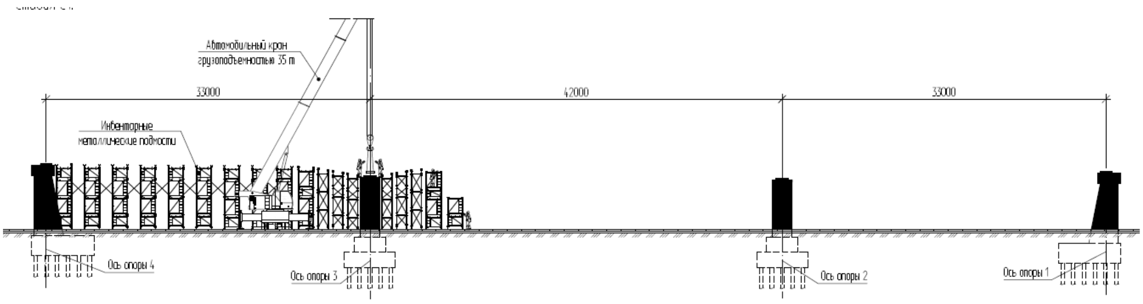


Fig. 8. Backfilling the excavation by layer-by-layer compaction

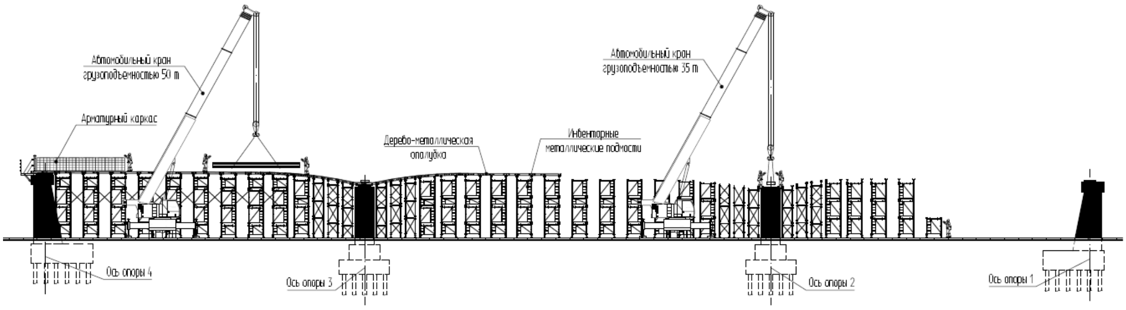
Works on the ***construction of span structures*** (Span1 and Span2) of the overpass are carried out on solid scaffolds in the following sequence (Fig. 9):

Construction of a foundation made of reinforced concrete slabs 2PDN-14 on a previously prepared crushed stone layer 15 cm thick with compaction coefficient $К_{упл}$ = 0.95.

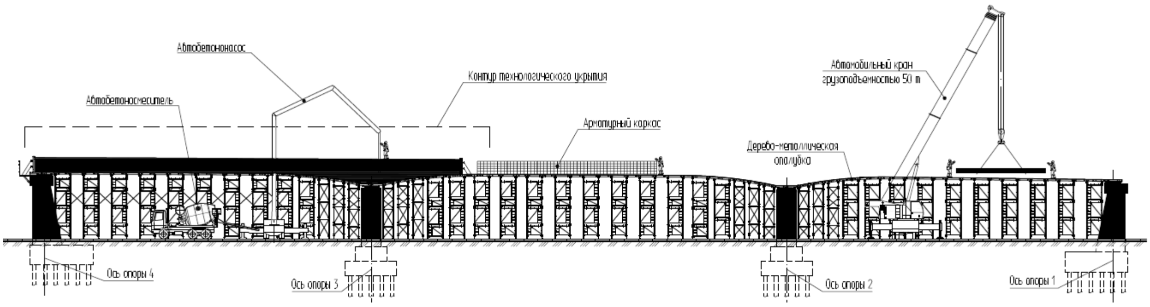
Seismic protection bearing parts made by Italian company “Fip Industriale” [5, 6] of the span structure Span1 are installed using a truck crane with a lifting capacity of 50 tons.



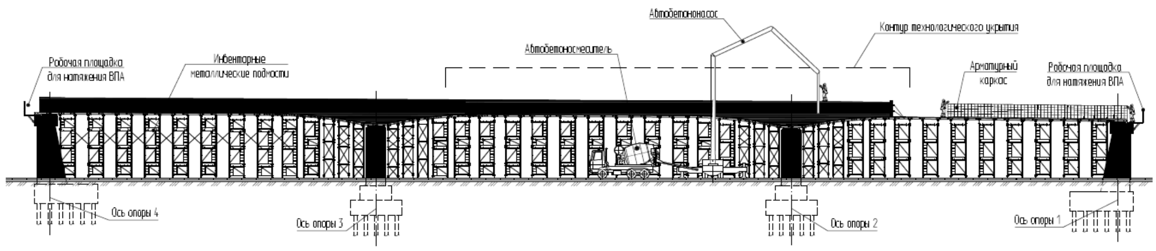
Stage 1



Stage 2



Stage 3



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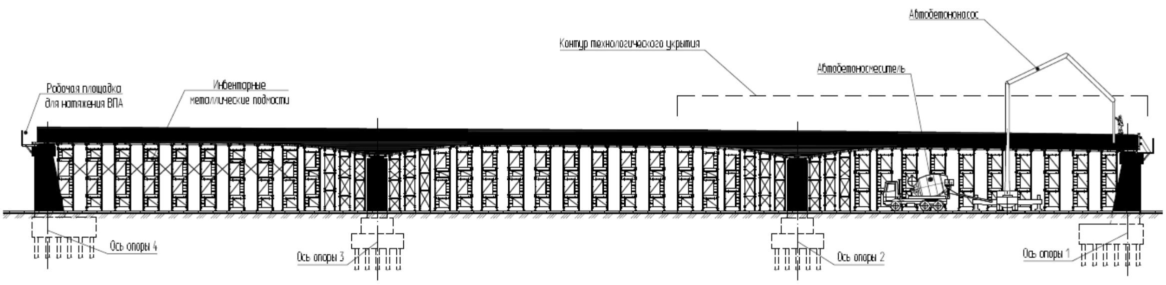
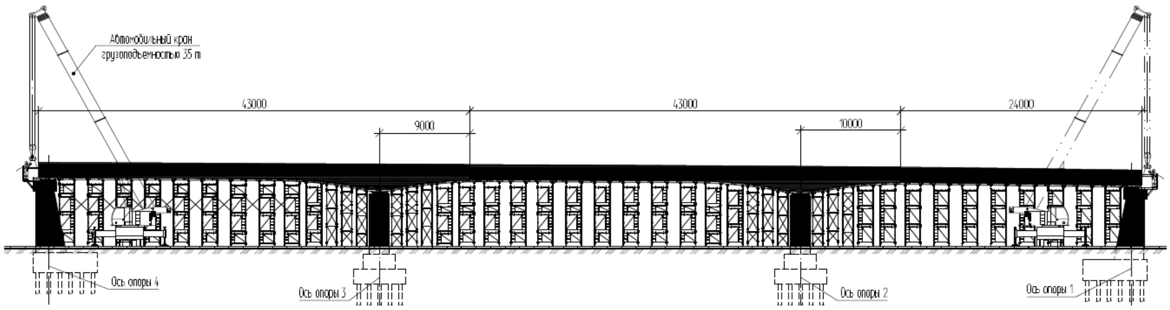


Stage 5



Stage 6

Fig. 9. Installation of scaffolds and formwork for concreting the span structure Span1

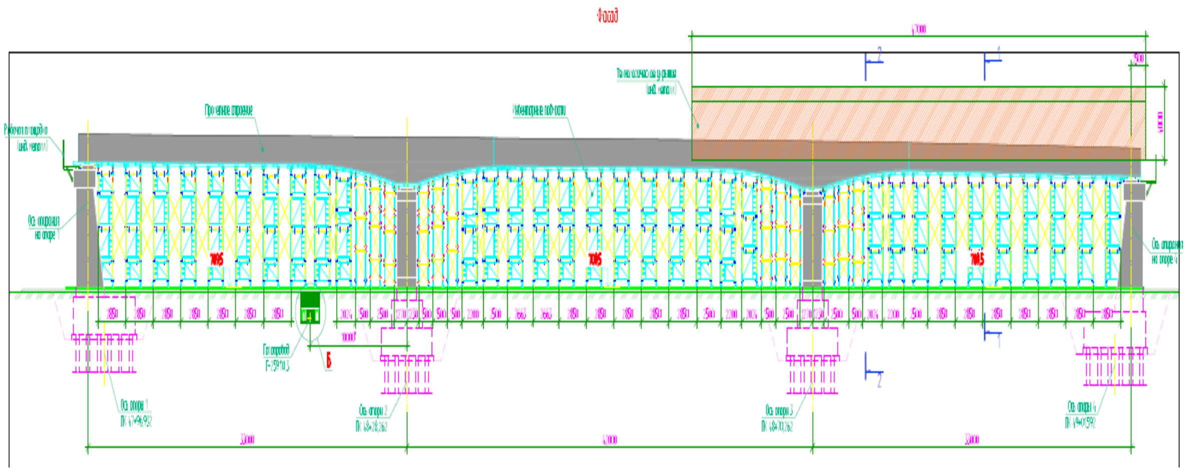
Installation of technological envelope.

Construction of the reinforcing cage of the first concreting section, installation of ductubes and void formers. Reinforcement and mounting elements are supplied using a truck crane with a lifting capacity of 50 tons (Fig. 10).

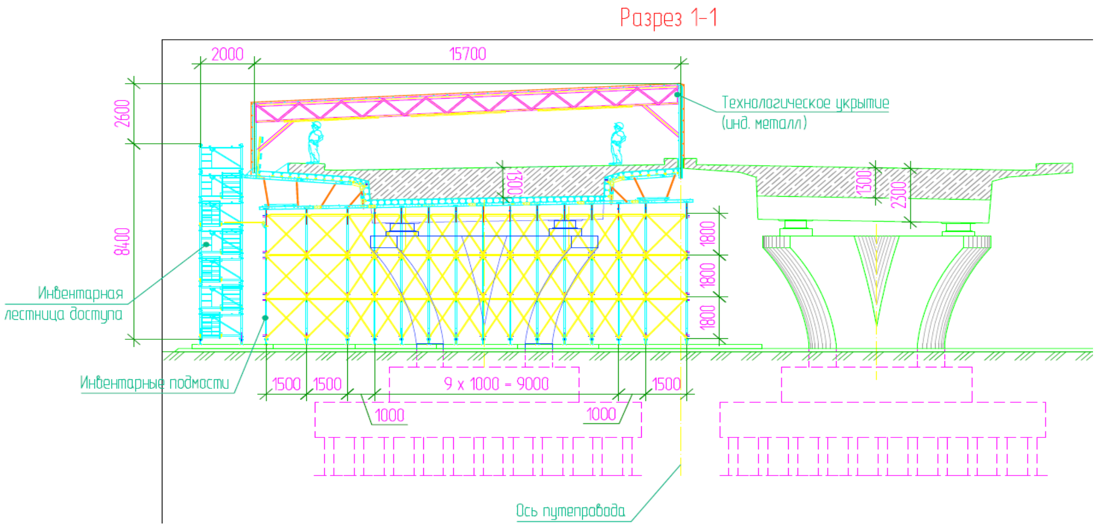
Concreting the grillages of abutments is carried out with truck-mounted concrete pumps. Concrete for monolithic structures is produced at the reinforced concrete fabricating yards of the city of Samarkand (the same as for abutments) and delivered to the construction site in concrete mixer trucks. Immediately after the completion of the concreting of the monolithic structure, the exposed surfaces are covered with envelopes that prevent water evaporation. These envelopes are kept until the concrete strength reaches at least 70% of the design strength. The second and third concreting sections are constructed similarly.

The placement of high-strength reinforcement into the ductubes is done.

After the concrete strength has reached at least 80% of the design strength in each concreting section, ***the tension of high-strength reinforcement*** of class K7 is carried out on both sides of the span structure; the ductubes are injected and anchor units are monolithically grouted at the ends of the span structure (Fig. 11).



a) special auxiliary structures and devices for the construction of a span structure, view along the facade



b) special auxiliary structures and devices for the construction of a span structure, view in cross-section

c)

d)

Fig. 10. Construction of span structures: a, b, c - special auxiliary structures and devices for the construction of a span structure; d - view of the overpass after completion of construction in Samarkand

After the tension of high-strength reinforcement, the formwork, scaffolding, and technological envelope are dismantled. In parallel, work is being done on concreting the berms on the span structure consoles [8].

Fig. 11. “Post tension” - further tension

Then the construction of the span structure Span2 is carried out similarly to the construction of the span structure Span1. After the dismantling of the formwork and scaffolding, the road surface of the M39 highway is restored and traffic is switched back from the bypass road.

Next, the embankment body is backfilled on the access roads. In the immediate vicinity of the overpass (about 10 m), embankments are backfilled to the level of the lower edge of the extensions. After the end sections gain the strength of at least 70% of the design one, the installation of reinforcement and formwork for backwalls and wing walls on piers No. 1 and No. 4 is carried out. Then concreting of backwalls and wing walls on piers No. 1 and No. 4 is done.

After the strength of backwalls and wing walls is at least 70% of the design one, the installation of reinforcement and formwork of approach slabs is carried out. Then the approach slabs are concreted. The span structures are being waterproofed. Finally, the formation of the embankment of the approaches, the laying of asphalt concrete pavement on the overpass and on the approaches, the installation of expansion joints made by the German company “Maurer-Sohne”, barrier fencing, railings and lighting poles are carried out.

After completion of all work on the construction of the overpass, the remediation of the construction site is done [9].

Conclusion. In recent years, many engineering structures have been built in Uzbekistan, in particular, bridges and overpasses. Analyzing the work performed during this period, we can say that in our Republic the experience in the design and construction of typical bridges shows the absence of architectural attractiveness and individuality. To avoid this shortcoming, the construction of monolithic bridges and overpasses nowadays is based on studying the design and construction skills in developed countries.

Practical recommendations were developed for the construction of monolithic bridges and overpasses, taking into account the seismic conditions of the Republic of Uzbekistan.

The technological process of monolithic construction is quite fast and economical in resources; the cost of work performed on this technology is much lower than that of other techniques. Based on this, we can say that the most important reserve for reducing the cost of construction (in terms of the monolithic method) is the constant improvement of operating procedures.

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