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# Investigation of Road Systems in Engineering-geological Condition of Kazakhstan

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***Abstract.*** *The purpose of the work is to present the results of the overpass structural survey and to determine the causes of the structural defects. Especially it is urgent task for countries with big and vast territory such as Kazakhstan. The territory is located in center of Eurasia, where are intersected many international ways between Europe and Asian countries from Ancient times to nowadays. One of the main international highway road is Yekaterinburg – Almaty (2336 km) which is one of main transportation road between Russia and Kazakhstan. Reconstruction of this road was done intensively in 2013. There is overpass construction which is constructed on section 1114-1137 km of Yekaterinburg – Almaty road. Unfortunately, deformation of bearing structures of overpass are detected during construction process. Therefore, it is proposed observation of deformed structures, soil ground. Before continuing construction process. The overpass is located in Zhaltyr village of Akmola region.*

***Keywords:*** *highway, overpass, deformation, observation, beams, standard, construction, cracks, strength, defects, destroy.*

## Introduction

The purpose of the construction of the overpass are ensuring traffic safety when crossing a railway road and ensuring continuous movement on this section of the route.

Seasonal freezing and thawing of the ground is an external influence on the condition of the girder structures. Technical inspection of the deformed section of the trestle and making technical decisions is the main task to ensure the safety and durability of the structure.

According to the road-climatic region, it belongs to the fourth climatic zone. The climate is characterized by sharp continental and low rainfall. Engineering and geological conditions of the overpass area were determined by Kazdorproject Ltd. in 2006. A layer of solid consistency sandy loam solid consistency lies to a depth of 3 m.

Below it passes a layer of semi-solid and solid consistency sandy clay. Then, there is gravel with sandy aggregate [1-2]. Photo of overpass is illustrated in Figure 1.

## Materials and research methods

The overpass is located on the straight section of the route in the plan and on the ascending branch of the convex vertical curve with a radius of 15,000 m in the longitudinal profile, in accordance with the necessary parameters for the II category of roads according to the requirements.

The width of the overpass was adopted in the carriageway 11.5 m with service passages of 0.75 m. The total length of the overpass is 70.8 m. The bridge clearance is 7 m.

The span structure is a split beam of three beam spans (21x24x21 m), with rubber-metal supports.

Roadway – with asphalt concrete pavement. Transverse slope of the roadway – 20%. Safety lanes – with cement concrete coating. Service walkways from paving blocks with reinforced concrete curb fences 0.75 m high. Railings – metal 1.1 m high.

Supports – reinforced concrete with a section of 40x60 cm on a natural base. The extreme supports of the viaduct are the bulk foundations of the gantry type. Intermediate supports – rack-mount single-row. In the foundation sockets, the stoics are mounted with the incorporation of monolithic concrete.

For monopolization with a crossbar, reinforcing outlets are provided in the racks. Crossbars in extreme support monolithic, in average support combined. On the crossbar, a device of sub-truss stones is provided for installing beams of the span.

Span beams prefabricated reinforced concrete pre-stressed double-tee sections of the VTK-21s and VTK-24s grades (according to the project B35, F200, W6); the length of the beams of the extreme spans is

21 m and the average span is 24 m.

Preparation and calibration of the concrete strength monitoring sensor.

The application of wireless sensors consists of three stages: preparation; calibration; installation [3].

Figures 3-6 presented defecting by cracks of the beams, underbeam concrete slabs and defects of concrete slabs.

**Results and discussion**

Underbeam concrete slabs (Figure 7) monolithic reinforced concrete (according to the project B25, F300, W6). They are arranged on the site above reinforced concrete crossbars. A general view of the sub-enzyme concrete slabs is shown in Figure 8.

The arrangement and marking of the sub-enzyme concrete slabs is shown in Figure 7. The main defects of the sub-enzyme concrete slabs are cracks with an opening width of up to 3 mm, spalls up to 30 mm deep caused by low concrete strength (class B5-B10).

According to the results of studies of concrete beams given in table 1, it was revealed that there are no deviations from the project.

The control points for measuring the strength of concrete were located on the side faces of the walls and flanges of reinforced concrete beams of the span (see Figure 7). The strength of concrete was determined at several points along the length of the beam (see Figure 8).

During the inspection of reinforced concrete beams of the span of the overpass, measures were taken to monitor the crack opening. Specialists of the laboratory of KGS LLP installed marks in the upper part of the shelf of the beams of the superstructure, as well as in the transition of the shelf to the wall from the inside of the beams. The position and width of the cracks were also recorded. The results of observation of crack opening during the monitoring period are

Figure 1 – Overpass

Figure 2 – Span beams before installation

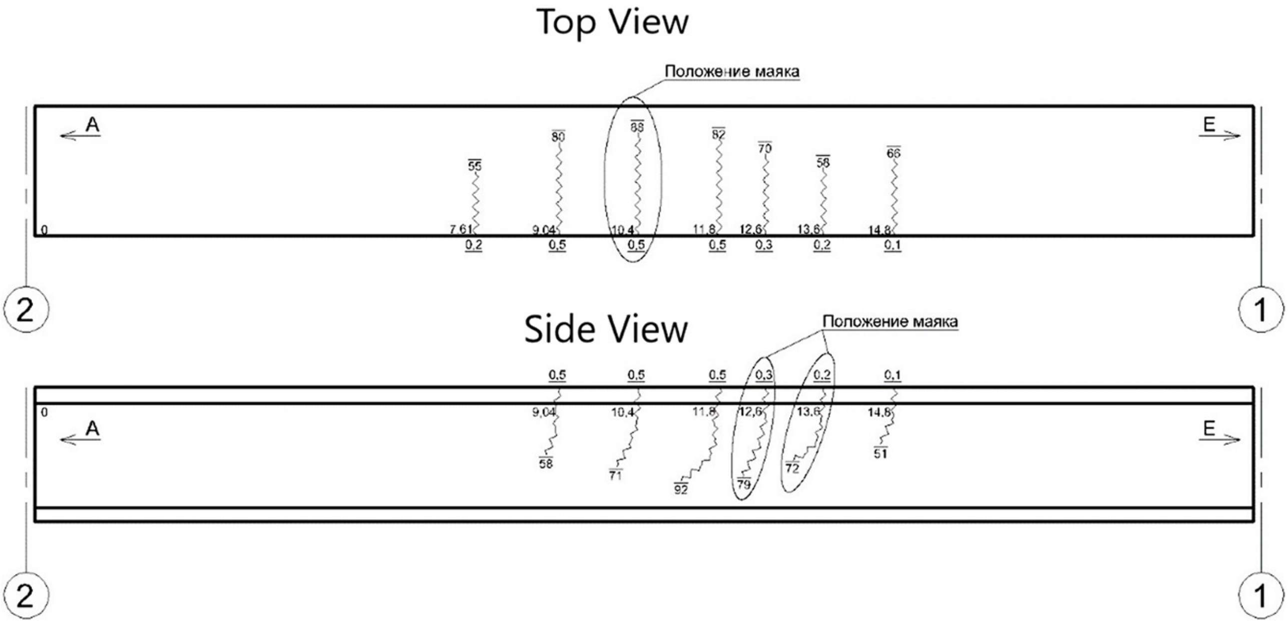


**Figure 3 – Defecting by cracks of the beams (top and side view)**

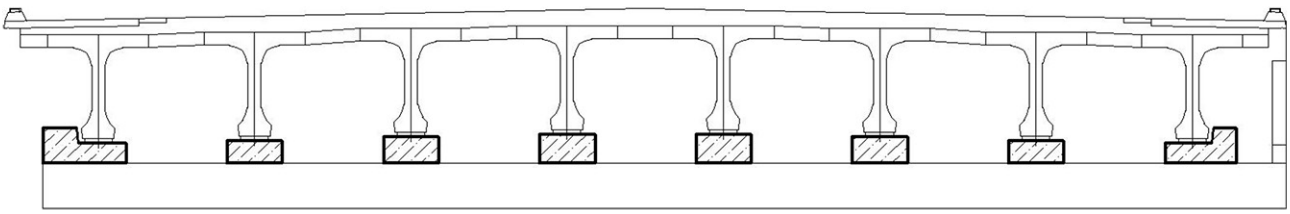

**Figure 4 – Underbeam concrete slabs**

**Figure 5 – General view underbeam concrete slabs**

**Figure 6 – Defects of concrete slabs**

Figure 7 – Span beam concrete strength test

**Table 1 – Results of average actual concrete strength**

| Mark | Required design strength of concrete | | Average actual concrete strength | |
|---|---|---|---|---|
| | $R_b$, MPa | Concrete class | $R_b$, MPa | Concrete class |
| Reinforced concrete beams prestressed beams | | | | |
| Б1-Е | 45.8 | B35 | 49.0 | B35 |
| Б2-Е | 45.8 | B35 | 51.2 | B35 |
| Б3-Е | 45.8 | B35 | 54.9 | B40 |
| Б4-Е | 45.8 | B35 | 48.9 | B35 |
| Б5-Е | 45.8 | B35 | 54.4 | B40 |
| Б6-Е | 45.8 | B35 | 46.7 | B35 |
| Б7-Е | 45.8 | B35 | 52.2 | B35 |
| Б8-Е | 45.8 | B35 | 44.7 | B35 |
| Б1-А | 45.8 | B35 | 47.4 | B35 |
| Б2-А | 45.8 | B35 | 43.9 | B35 |
| Б3-А | 45.8 | B35 | 51.1 | B35 |
| Б4-А | 45.8 | B35 | 49.3 | B35 |
| Б5-А | 45.8 | B35 | 52.1 | B35 |
| Б6-А | 45.8 | B35 | 55.5 | B40 |
| Б7-А | 45.8 | B35 | 52.0 | B35 |
| Б8-А | 45.8 | B35 | 49.1 | B35 |

shown in table 2.

Monitoring showed that the development of cracks does not occur, since the beams are in the design position and are not loaded.

The strength of concrete was determined using the IPS-MG4 device on the side faces of the sub-truss stones of the extreme and middle supports, as well as selectively in the middle supports, according to the instructions of the customers.

According to the results of studies of the concrete strength of monolithic sub-truss stones given in table 3, it was revealed that there are deviations from the design data.

**Table 2 – Results of crack size**

| Sketches of the monitoring sites | Crack sizes, mm | | Crack increment, mm |
|---|---|---|---|
| | 03.11.2013 | 10.11.2013 | |
| Top of girder flange B3-E | 1.5 | 1.5 | 0.0 |
| Top of girder flange B8-E | 1.4 | 1.4 | 0.0 |
| Flange to flange transition of B3-E girder | 0.6 | 0.6 | 0.0 |
| Flange to flange transition of B8-E girder | 0.5 | 0.5 | 0.0 |

**Table 3 – Results of average actual concrete strength**

| Mark | Required design strength of concrete | | Average actual concrete strength | |
|---|---|---|---|---|
| | $R_b$, MPa | Class of concrete | $R_b$, MPa | Class of concrete |
| Prestressed concrete beams BTK-21s | | | | |
| K-1-1 | 32.7 | B25 | 18.9 | B15 |
| K-1-2 | 32.7 | B25 | 19.4 | B15 |
| K-1-3 | 32.7 | B25 | 19.2 | B15 |
| K-1-4 | 32.7 | B25 | 15.9 | B12.5 |
| K-1-5 | 32.7 | B25 | 13.1 | B10 |
| K-1-6 | 32.7 | B25 | 19.0 | B15 |
| K-1-7 | 32.7 | B25 | 18.8 | B15 |
| K-1-8 | 32.7 | B25 | 26.2 | B20 |
| K-4-1 | 32.7 | B25 | 26.2 | B20 |
| K-4-2 | 32.7 | B25 | 16.1 | B12.5 |
| K-4-3 | 32.7 | B25 | 26.2 | B20 |
| K-4-4 | 32.7 | B25 | 19.6 | B15 |
| K-4-5 | 32.7 | B25 | 16.3 | B12.5 |
| K-4-6 | 32.7 | B25 | 26.2 | B20 |
| K-4-7 | 32.7 | B25 | 19.1 | B15 |
| K-4-8 | 32.7 | B25 | 19.2 | B15 |
| K-3-8 | 32.7 | B25 | 6.0 | B5 |
| K-3-7 | 32.7 | B25 | 5.9 | B5 |
| K-3-6 | 32.7 | B25 | 6.4 | B5 |
| K-3-5 | 32.7 | B25 | 6.2 | B5 |
| K-2-5 | 32.7 | B25 | 6.1 | B5 |
| K-2-4 | 32.7 | B25 | 6.0 | B5 |

**Conclusion**

According to the results of a technical observation of the concrete beams of the span and underbeam concrete slabs of the overpass, their condition according to SN RK 1.04-04-2002 [5] is estimated as follows:

- spans: B1-E, B3-E, B5-E, B8-E, B4-A, B5-A, B6-A, B7-A, B8-A – category III (limited workable design): there are damage indicating a decrease in the bearing capacity and operational suitability of the structure, but at the time of examination not endangering the safety of workers and collapse;

- underbeam concrete slabs – category IV (pre-emergency state of construction), the results of determining the strength of concrete stones showed that all underbeam concrete slabs did not gain design strength (B25), especially low-strength concrete (B5) has truss stones along axes 2 and 3 (middle supports). The cause of defects is basically improper care of the concrete and possible freezing of the concrete during hydration.

Figure 8 – Strength test of underbeam concrete slabs

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### ***Қазақстанның инженерлік-геологиялық жағдайларында жол жүйелерін зерттеу***


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***Аңдатпа.*** *Инфрақұрылымның (жолдардың, инженерлік жүйелердің және т.б.) қауіпсіздігі мен жұмыс істеуі кез келген елдің экономикалық дамуының негізгі факторларының бірі болып табылады. Бұл әсіресе Қазақстан сияқты аумағы үлкен және кең елдер үшін өзекті. Қазақстан аумағы ежелгі дәуірден бүгінгі күнге дейінгі Еуропа мен Азия елдері арасындағы көптеген халықаралық жолдар қиылысатын Еуразияның орталығында орналасқан. Басты халықаралық автомагистральдардың бірі – Ресей мен Қазақстан арасындағы негізгі көлік магистральдарының бірі болып табылатын Екатеринбург – Алматы (2336 км). Бұл жолды қайта құру 2013 жылы қарқынды жүргізілді. Екатеринбург – Алматы жолының 1114-1137 км учаскесінде эстакада салынды. Өкінішке орай, құрылыс процесінде жол өтпесінің тірек конструкцияларының деформациясы табылды. Сондықтан құрылысты жалғастырмас бұрын деформацияланған құрылымдарды, негіз топырағын зерттеу ұсынылады. Эстакада Ақмола облысының Жалтыр ауылында орналасқан.*

***Кілт сөздер:*** *тас жол, эстакада, деформация, бақылау,арқалықтар, стандарт, құрылым, жарықтар, беріктік, ақаулар, бұзылу.*

***Исследование дорожных систем в инженерно-геологических условиях Казахстана***

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***Аннотация.*** *Безопасность и функциональность инфраструктуры (дорог, инженерных систем и др.) являются одними из основных факторов экономического развития любой страны. Особенно это актуально для стран с большой и обширной территорией, таких как Казахстан. Территория Казахстана расположена в центре Евразии, где пересекаются многие международные пути между Европой и странами Азии с древнейших времен до наших дней. Одна из главных международных автомагистралей – Екатеринбург – Алматы (2336 км), которая является одной из основных транспортных магистралей между Россией и Казахстаном. Реконструкция этой дороги была интенсивно проведена в 2013 году. На участке 1114-1137 км дороги Екатеринбург – Алматы построена эстакада. К сожалению, в процессе строительства обнаружены деформации несущих конструкций путепровода. Поэтому предлагается провести обследование деформированных конструкций, грунта основания перед продолжением строительства. Эстакада расположена в селе Жалтыр Акмолинской области.*

***Ключевые слова:*** *шоссе, эстакада, деформация, наблюдение, балка, стандарт, конструкция, трещины, прочность, дефекты, разрушение.*

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