IRSTI 67.11.29

Zh. Shakhmov, G. Tleulenova*, Ye. Utepov

L.N. Gumilyov Eurasian National University, Astana, Kazakhstan
*E-mail: zhanbolat8624@mail.ru, *gulshattlelenova23@mail.ru, utepov-elbek@mail.ru*

Survey of overpass foundation in engineering-geological condition of Kazakhstan

Abstract. The aim of the work is to present the results of the inspection of the foundations of the overpass and to determine the causes of the defects. This is a particularly relevant task for countries with a large and extensive territory, such as Kazakhstan. This area is located in the centre of Eurasia, where many international routes between Europe and Asian countries have crossed since ancient times until the present day. One of the main international highways is Yekaterinburg - Almaty (2336 km), which is one of the main transport routes between Russia and Kazakhstan. This road was intensively reconstructed in 2013. An overpass was built on the 1114-1137 km section of the Yekaterinburg - Almaty Road. Unfortunately, there was downtime in the construction process. It is therefore proposed to inspect the foundations of the structures, the subgrade soil before continuing the construction. The overpass is located in the village of Zhaltyr, Akmola region.
Keywords: highway; overpass; deformation; survey, foundations, defects.

DOI: doi.org/10.32523/2616-7263-2023-142-1-116-126

Introduction

The purpose of the overpass construction is to ensure traffic safety when crossing the railway and to ensure uninterrupted traffic on this section of the route.

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

In terms of the climatic region, the trestle relates to the fourth climatic zone. The climate is characterised by a strong continental climate and low precipitation. Engineering and geological conditions of the overpass area were determined by Kazdorproject Ltd. in 2006. At a depth of 3 m there is a layer of sandy loam of hard consistency.

Under it there is a layer of sandy clay of semi-solid and hard consistency. This is followed by gravel with sandy aggregate [1-2]. A scheme of the overpass is shown in Figure 1.

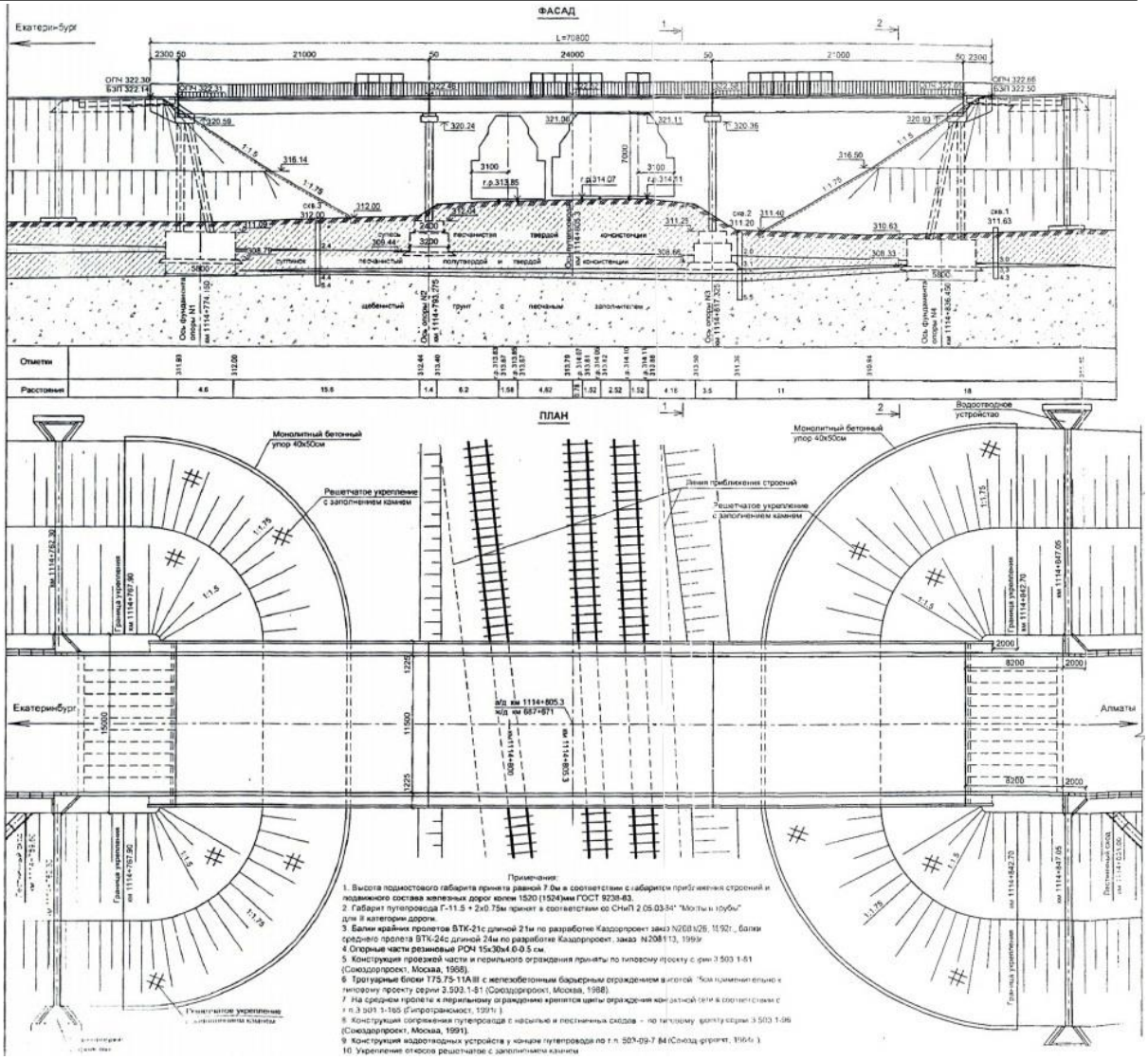


Figure 1. Overpass drawings

Materials and research methods

The overpass is located on a straight section of the route in plan and on an ascending branch of a convex vertical curve with a radius of 15,000 m in longitudinal profile, in accordance with the required parameters for road category II as required.

The width of the overpass is accepted on the carriageway 11,5 m with operational passages of 0,75 m. The total length of the overpass is 70.8 m. The span of the bridge is 7 m.

The bridge superstructure is a sectional beam of three girder spans (21x24x21 m), with rubber-metal supports.

The carriageway is paved with asphalt concrete. The cross slope of the carriageway is 20%. Safety lanes are paved with cement concrete. Service pedestrian paths - paving stone with reinforced concrete curbs 0,75 m high. Railings - metal 1.1 m high.

The visual and instrumental inspection of the monolithic foundations (MF) included:

- inspection of the conditions of the MF;
- inspection of the quality of the MF surfaces;
- verification of compliance of the actual dimensions of the MFs with the design ones.

The general view if foundations are presented in figure 2.

Figure 2. Foundations

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 (Figure 3).

Figure 3. Supports and beams

Results and discussion

Visual and instrumental inspection of the monolithic foundations of MF#1, MF#2, MF#3, MF#4 revealed defects such as:

- delamination and spalling on the surface of foundations (Figure 4);
- cracks on the surface of monolithic foundations (figure 5);
- Exposed rebar in foundation pits.

Figure 4. Failure of concrete foundations

Figure 5. Chips and potholes found on foundations

Instrumental inspection of foundations revealed geometric deviations from their design dimensions of MF №3 foundation by 10-12 cm (Figure 6).

Figure 6. Detected defects in foundation structures

Corrosion of the reinforcement in the foundation wells is shown in Figure 7.

Figure 7. Corrosion of fittings in foundation wells for props

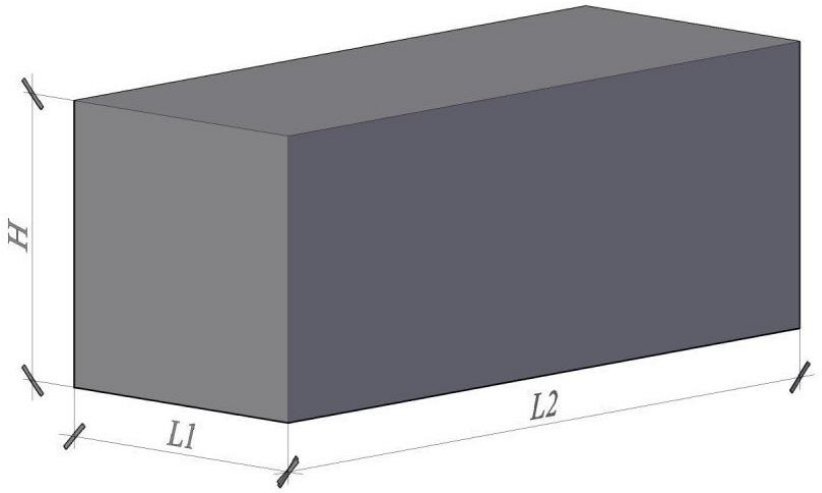
Cracks on the surface of the foundation are shown in Figure 8.

Figure 8. Cracks in the surface of the MF#4 foundation

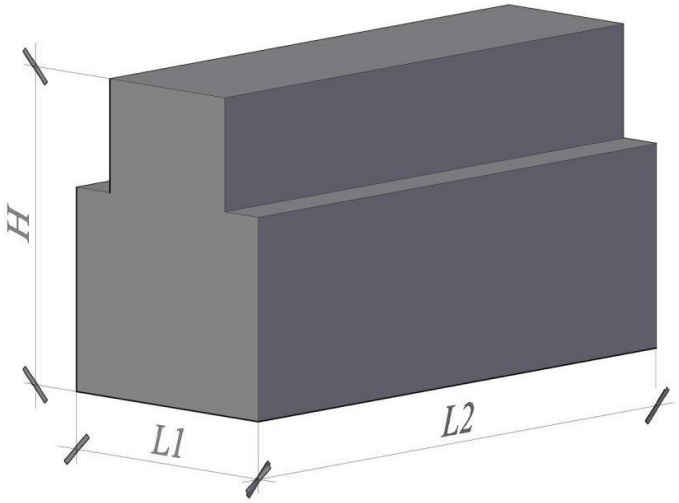
Voids under the foundation of MF3 are shown in Figure 9.

Figure 9. Voids underneath the bottom of the MF#3 foundation

Determination of actual strength of reinforced concrete monolithic structures conducted by KGS LLP testing laboratory was carried out by non-destructive method, using IPS-MG4 device (electronic concrete strength meter) according to Figure 10.



Фундаменты МФ №1, №4												
L_1=5,8м		L_2=16м				L_1=5,8м		L_2=16м				
49	50	51	52	53	54	55	56	57	58	59	60	H=2,3м
37	38	39	40	41	42	43	44	45	46	47	48	
25	26	27	28	29	30	31	32	33	34	35	36	
13	14	15	16	17	18	19	20	21	22	23	24	
1	2	3	4	5	6	7	8	9	10	11	12	



Foundations МФ №2, №3							
L_1=3,2m			L_2=13,8m				
	25	26	27	28	29	30	H=2,6m
	19	20	21	22	23	24	
13	14		15	16	17	18	

7	8	9	10	11	12	
1	2	3	4	5	6	

Figure 10. Dimensioning the monolithic foundation along the edges

The results of the investigation presented in Table 1 showed that the concrete strength corresponds to the required design strength.

Table 1. Comparison of actual and design concrete strength

Item brand	**Required design strength of concrete**		**Average actual concrete strength**		**Safety margin, %**	
	Rь, MPa	**Concrete grade**	**Rb, MPa**	**Concrete grade**		
Monolithic foundations						**Monolithic foundations**
MF#1(1-12)	32,7	B25	32,9	B25	1	
MF#1(13-24)	32,7	B25	33,0	B25	1	
MF#1(25-36)	32,7	B25	36,0	B27,5	9	
MF#1(37-48)	32,7	B25	36,6	B27,5	11	
MF#1(49-60)	32,7	B25	42,2	B30	23	
TOTAL:						
Average safety margin of MF No. 1					**9%**	
MF#2(1-6)	32,7	B25	36,0	B27,5	9	
MF#2(7-12)	32,7	B25	36,4	B27,5	10	
MF#2(13-18)	32,7	B25	41,5	B30	21	
MF#2(19-24)	32,7	B25	41,1	B30	20	
MF#2(25-30)	32,7	B25	36,3	B27,5	10	
TOTAL:						
Average safety margin of MF No. 2					**14%**	
MF#3(1-6)	32,7	B25	40,3	B30	19	
MF#3(7-12)	32,7	B25	36,0	B27,5	9	
MF#3(13-18)	32,7	B25	36,6	B27,5	11	
MF#3(19-24)	32,7	B25	29,3	B20	-12	
MF#3(25-30)	32,7	B25	36,5	B27,5	10	
TOTAL:						
Average safety margin of MF No. 3					**7,4%**	
MF#4(1-12)	32,7	B25	41,5	B30	21	
MF#4(13-24)	32,7	B25	41,4	B30	21	
MF#4(25-36)	32,7	B25	42,5	B30	23	

MF#4(37-48)	32,7	B25	36,8	B27,5	11
MF#4(49-60)	32,7	B25	36,6	B27,5	11
TOTAL:					
Average safety margin of MF No. 4					**17,4%**

According to the actual concrete strength test results, concrete grade B25 M350 has a safety margin:

- for MF#1 was 9%;
- for MF#2 was 14%;
- for MF#3 was 7.4%;
- for MF#4 was 17.4%.

which indicates that the concrete of the monolithic foundations has sufficient strength.

Conclusion

The assessment of the reliability and quality of the monolithic foundations has been carried out in accordance with GOSTs and SNiPs of RK [1-3].

Visual and instrumental inspection of the monolithic foundations (MF#1, MF#2, MF#3, MF#4) did not reveal any serious damages and deviations from GOSTs. All foundations have defects in the form of spalling, delamination, cracks, in some parts the armature is bare.

The actual concrete strength of the monolithic foundations corresponds to the design strength.

According to the results of determining the protective layer of concrete, the maximum deviation was +5-8 mm, which corresponds to the requirements [2].

The inspection of the monolithic foundations for continuity showed the absence of cracks and voids within the bodies of the foundations.

References

1. Report on the results of the technical inspection of reinforced concrete structures at the facility: "Reconstruction of the Russian Federation Border Road to Yekaterinburg - Almaty km 1114-1137 (overpass)", KGS Ltd., 2012.

2. СП РК EN 1997-2:2004/2011 «Геотехническое проектирование. Часть2. Исследования и испытания грунта.

3. Teltayev, B.B., Zhussupbekov, A., Shakhmov, Z., Suppes, E.A. Field experimental investigations of freezing and thawing of highway subgrade // Lecture Notes in Civil Engineering, Volume 49, 2020 – P. 35–47.

Ж.А. Шахмов, Г.Т. Тлеуленова, Е.Б. Утепов

Л.Н. Гумилев атындағы Еуразия ұлттық университеті, Астана, Қазақстан

Қазақстанның инженерлік-геологиялық жағдайында құбырдың негізін зерттеу

Аңдатпа. Жұмыстың мақсаты – эстакаданың іргетасын тексеру нәтижелерімен таныстыру және ақаулардың себептерін анықтау. Бұл Қазақстан сияқты үлкен және кең аумақты елдер үшін өте өзекті міндет. Бұл аймақ Еуразияның орталығында орналасқан, мұнда Еуропа мен Азия елдері арасындағы көптеген халықаралық маршруттар көне заманнан бүгінгі күнге дейін кесіп өткен. Негізгі халықаралық автомобиль жолдарының бірі Екатеринбург – Алматы (2336 км) Ресей мен

Қазақстан арасындағы негізгі көлік бағыттарының бірі болып табылады. Бұл жол 2013 жылы қарқынды түрде қалпына келтірілді. Екатеринбург-Алматы жолының 1114-1137 км учаскесінде жол өтпесі салынды. Өкінішке орай, құрылыс барысында тоқтаулар болды. Сондықтан құрылысты жалғастырмас бұрын құрылымдардың іргетасын, жер асты топырақтарын тексеру ұсынылады. Жол өткелі Ақмола облысының Жалтыр ауылында орналасқан

Түйін сөздер: тас жол; эстакада; деформация; түсіру, іргетас, ақаулар.

Ж.А. Шахмов, Г.Т. Тлеуленова, Е.Б. Утепов

Евразийский национальный университет им. Л.Н. Гумилева, Астана, Казахстан

Обследование основания путепровода в инженерно-геологических условиях Казахстана

Аннотация. Цель работы - представить результаты обследования фундаментов путепровода и определить причины дефектов. Это особенно актуальная задача для стран с большой и разветвленной территорией, таких как Казахстан. Этот район расположен в центре Евразии, где с древних времен до наших дней пересекались многие международные маршруты между Европой и азиатскими странами. Одной из главных международных магистралей является Екатеринбург - Алматы (2336 км), основной транспортный маршрут между Россией и Казахстаном. Эта дорога была интенсивно реконструирована в 2013 году. Путепровод был построен на участке 1114-1137 км автодороги Екатеринбург - Алматы. К сожалению, в процессе строительства произошел простой. Поэтому предлагается осмотреть фундаменты сооружений, грунт земляного полотна, прежде чем продолжать строительство. Путепровод расположен в селе Жалтыр Акмолинской области.

Ключевые слова: шоссе, путепровод, деформация, обследование, фундаменты, дефекты.

References

1. Report on the results of the technical inspection of reinforced concrete structures at the facility: "Reconstruction of the Russian Federation Border Road to Yekaterinburg - Almaty km 1114-1137 (overpass)", KGS Ltd., 2012.
2. СП РК EN 1997-2:2004/2011 «Геотехническое проектирование. Часть2. Исследования и испытания грунта.
3. Teltayev, B.B., Zhussupbekov, A., Shakhmov, Z., Suppes, E.A. Field experimental investigations of freezing and thawing of highway subgrade // Lecture Notes in Civil Engineering, Volume 49, 2020 – P. 35–47.

Information about authors:

Zh. Shakhmov – PhD, associate professor, Department of Civil Engineering, L.N. Gumilyov Eurasian National University, 2 Satpayev str., Astana, Kazakhstan.

G. Tleulenova – PhD, acting associate professor Department of Civil Engineering, L.N. Gumilyov Eurasian National University, 2 Satpayev str., Astana, Kazakhstan.

Ye. Utepov – PhD, professor, Department of Civil Engineering, L.N. Gumilyov Eurasian National University, 2 Satpayev str., Astana, Kazakhstan.

Ж.Ә. Шахмов – PhD, доцент, құрылыс кафедрасы, Л.Н. Гумилев атындағы Еуразия ұлттық университеті, Сәтпаев көш., 2, Астана, Қазақстан.

Г.Т. Тлеуленова – PhD, доцент м.а., құрылыс кафедрасы, Л.Н. Гумилев атындағы Еуразия ұлттық университеті, Сәтпаев көш., 2, Астана, Қазақстан.

Е.Б. Утепов – PhD, профессор, құрылыс кафедрасы, *Л*.Н. Гумилев атындағы Еуразия ұлттық университеті, Сәтпаев көш., 2, Астана, Қазақстан.

Ж.А. Шахмов – PhD, доцент, кафедра строительство, Евразийский национальный университет имени *Л*.Н. Гумилева, ул. Сатпаева, 2, Астана, Казахстан.

Г.Т. Тлеуленова – PhD, и.о. доцента, кафедра строительство, Евразийский национальный университет имени *Л*.Н. Гумилева, ул. Сатпаева, 2, Астана, Казахстан.

Е.Б. Утепов – PhD, профессор, кафедра строительство, Евразийский национальный университет имени *Л*.Н. Гумилева, ул. Сатпаева, 2, Астана, Казахстан.