# Section 5. Technical sciences in general

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## ASSESSMENT OF THE TECHNICAL CONDITION OF A ROAD BRIDGE

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**Abstract**
The article presents the results of a survey of road bridges and the calculation of the span on the possibility of passing A14 and NK100 loads. It is given that the actual bearing capacity of the beams of the superstructures is insufficient for the passage of loads A14 and NK100.
**Keywords:** *Road Bridge, survey results, carrying capacity, durability*

The main objective of inspecting operating bridges is to assess their technical condition and verify their compliance with established requirements.

The road reinforced concrete bridge we inspected is located at kilometer 1333+14 on the M39 highway "Tashkent – Termez". The bridge is a three-span structure with a 3x16,5 m layout. The year of construction is unknown (Saatova N.Z., 2019).

The following was established as a result of the inspection of the superstructure:

During the planned reconstruction, a separate bridge is to be constructed.

The superstructures of the bridge consist of ribbed beams, which, based on their geometric dimensions, correspond to standard design inventory No. 56D.

Numerous damages were found in the superstructures, which reduce their load-bearing capacity and durability:

Due to prolonged use and the faulty condition of the waterproofing and expansion joints, water from the roadway has been constantly seeping onto the superstructure and supports. As a result, there are signs of leaching and corrosion on the surface of the beams and the concrete monolith between them (Photo 1);

The ends of the outer beams in spans No. 1 and 2 are damaged due to concrete corrosion (Photo 2);

In the middle of the outer beam of span No. 1, a critical through-crack was identified, extending into the compressed concrete zone. The width of this crack reaches up to 5 mm (Photo 3). The bottom part of the beam is almost completely destroyed. Strengthening or replacement of this beam is required;

All beams exhibit diagonal and vertical cracks with widths up to 0,2 mm, while in the outer beams the diagonal crack widths reach up to 0,3 mm;

The concrete of the crossbeams is corroded, and the surfaces of the structures are covered with a network of cracks (Photo 4);

Based on the results of measuring the longitudinal profile of the bridge along the roadway, it appears that the river piers have settled by 30–40 cm due to scouring of the foundation (Photo 5).

**Photo 1.** *Traces of leaching and corrosion on the surface of the beams and the monolithic concrete between them*

**Photo 2.** *Concrete corrosion at the ends of the outer beams*

**Photo 3.** *Through-crack in the middle of the outer beam of the span, with a crack width of up to 5 mm*

**Photo 4.** *Corrosion of the crossbeam concrete and a network of cracks on its surface*

**Photo 5.** *Scouring of the bridge foundation*

**Photo 6.** *Damage to the lower part of the beam rib*

**Table 1.** *Results of Concrete Strength Testing of Superstructures and Supports*

| No. | Name of the structure | Span number | Location of the element (Beam number) | Experimental strength values, MPa. 1 | 2 | 3 | 4 | Average strength value, MPa. |
|---|---|---|---|---|---|---|---|---|
| 1. | Intermediate structures | 1 | 1 | 28 | 31 | 40 | 36 | 33.7 |
| | | | 2 | 36 | 36 | 34 | 39 | 36.25 |
| | | | 8 | 28 | 36 | 36 | 29 | 32.25 |
| 2. | | 4 | 1 | 34 | 29 | 39 | 36 | 34.5 |
| | | | 4 | 40 | 38 | 38 | 36 | 38.0 |
| | | | 8 | 28 | 29 | 36 | 29 | 30.5 |
| 3. | Monolithic concrete | 1 | 1–2 | 24 | 25 | 23 | 27 | 24.75 |
| | | | 7–8 | 26 | 24 | 25 | 27 | 25.5 |
| | | 4 | 1–2 | 22 | 24 | 23 | 26 | 23.75 |
| | | | 5–6 | 27 | 22 | 25 | 23 | 24.25 |

For the calculation of the superstructures, the concrete strength is taken as:
- For the outer beams – 30.5 MPa;
- For the middle beams – 36.25 MPa.

## Calculation of the superstructure for the ability to withstand loads A14 and NK100

*Here are the initial data for the calculation:*

Bridge layout: 3×16.5 m, span $l_p = 17.4m$, superstructure: ribbed beams 56D, Number of beams: 8, Actual concrete strength $R_в = 13.0\,\text{MPa}$.

Self-weight of the beam $q_g = 11.7\ kN/m$,

Self-weight of the beam per span width

$$q_{c.в} = q_g \cdot n = 70.2 kN/m$$

Weight of the sidewalks with a width of l = 0.75 m and the median strip

$$q_{m.b} = 25kN/m = 12.5$$

Weight of the superstructure across the entire width

$$q_{n.c} = q_{c.в} + q_t = 82.7 kN/m$$

Weight of the road pavement: asphalt concrete $\delta = 0.07m$

— on the roadway $q_a = \delta \cdot в \cdot 23 = 17.42\text{kN/m}$

— on the pedestrian part of the sidewalk $q_T = 0.04 \cdot в_T \cdot 23 = 0.4\,\text{kN/m}$

Total weight of the pavement and sidewalks

$$q_e = q_a + q_T = 38.9\,\text{kN/m}$$

Protective layer $q_3 = h \cdot в \cdot 25 = 76.7\,\text{kN/m}$

Waterproofing $q_Г = 0.04 \cdot в \cdot 15 = 3.8\,\text{kN/m}$

Cement screed $q_ц = 0.03 \cdot в \cdot 21 = 15.9\text{kN/m}$

Total weight of the protective and leveling layers

$$q_в = q_3 + q_Г + q_ц = 18.82\,\text{kN/m}$$

Load on one slab from its own weight

$$q_1 = \frac{q_{nc}}{n} = 10.75\,\text{kN/m}$$

Load from the roadway pavement and sidewalks $q_2 = \frac{q_e}{n} = 1.15\,\text{kN/m}$

Load from the leveling, insulating, and protective layers

$$q_3 = \frac{q_в}{n} = 3.85\,\text{kN/m}.$$

*Coefficients*

Reliability coefficient for the self-weight of structures $\gamma_{f_1} = 1.1\text{m}$

Reliability coefficient for the pavement layer $\gamma_{f_2} = 1.5\text{m}$

Reliability coefficient for the leveling, insulating, and protective layers $\gamma_{f_3} = 1.3\text{m}$

Reliability coefficient for strip load $\gamma_{f_A} = 1.2\text{m}$

Reliability coefficient for the trolley $\gamma_{f_{AA}} = 1.5 - 0.01\lambda = 1.33\text{m}$

Reliability coefficient for pedestrian load on the sidewalk $\gamma_{f_Г} = 1.2\text{m}$

Reliability coefficient for NK100 load $\gamma_{f_k} = 1.0\text{m}$

*Dynamic coefficients*

For A14: $(1+\mu)_A = 1 + \frac{45-\lambda}{135} = 1.21$

For NK100: $(1+\mu)_K = 1.1$

Intensity of strip load A14: $q_{gjR} = 14\,\text{kN/m}$

Pressure on the axle from A14: $P_{am} = 140 \cdot kN$

Intensity of uniformly distributed crowd load: $P_m = 4 - 0{,}02\lambda\,\text{kPa}$

Pressure on the axle of special machinery NK100: $P_K = \frac{100}{4} = 140\,kN$

Transverse installation coefficients

A14 is as close as possible to the curb: КПУ$_A$= 0,133; КПУ$_{AT}$=0,176; КПУ$_{НК}$= 0,076

Area of influence line for the middle of the span: $w_м = \frac{1}{2} l_p \cdot \frac{l_p}{4} = 37.845\,m^2$

Area of influence line at the support: $w_a = \frac{1}{2} l_p = 8.7\,m$

*Bending moments at the middle of the span.*

From permanent loads

$M_q = (\gamma_{f1} q_1 + \gamma_{f2} q_2 + \gamma_{f3} q_3) w_M = 702.2\,kNm$

A-14 positioned as close as possible to the curb:

$$M = (1+\mu)_A (\gamma_{fA} q_{пол} КПУ_A \cdot w_M +$$
$$+ \gamma_{fAT} P_{AT} \cdot КПУ_{AT} \cdot \sum_1^2 y_i = 407.25\,kNm$$

NK100: $M = (1+\mu)_K \gamma_{fK} P_к КПУ_K \sum_1^4 y_i =$
$= 405.25\,kNm$

Maximum bending moment from permanent and temporary loads for strength calculation $M_p = M_g + M_v = 1109\,kNm$

Ultimate bending moment $M_{пред} = 1110\,kNm$

Verification $M_{пред} < M_p \quad 1110 \approx 1109\,kNm$

## Results of the superstructure calculations

The calculation was performed according to SHNK 2.05.03–12 "Bridges and Culverts" with consideration of the recommendations (SHNK 2.05.03–12; KMK 3.06.07–96; MSHN 4–2004).

The analysis of the calculation shows that the calculated loads from external influences exceed the ultimate bending moment values, calculated considering the actual condition of the superstructure beams.

## Conclusions:

Prolonged Operation and Damage: During the extended operation of the reinforced concrete road bridge on the 1333+14 km section, continuous wetting of the superstructures occurred due to the failure of the waterproofing layer. As a result, signs of leaching and concrete corrosion were found on the surface of the beams.

Failure of Expansion Joints: Due to the failure of expansion joints over many years, surface water constantly affected the ends of the beams and supports. The ends of the outer beams in spans No. 1 and 2 have been destroyed due to concrete corrosion.

Beam Condition: The outer beam of span No. 1, with unacceptable through-cracks in the middle of the span, requires either replacement or reinforcement.

Cracking on All Beams: All beams of the superstructure have diagonal and vertical cracks, with the width of the diagonal cracks reaching up to 0.3 mm.

Geodetic Survey Recommendations: It is recommended to conduct detailed geodetic studies to determine the potential settlement of support No. 3.

Insufficient Load-Bearing Capacity: The actual load-bearing capacity of the superstructure beams is insufficient to accommodate the loads from A14 and NK100 (MSHN 32–2004). The load-bearing capacity can be increased through reinforcement of the beams using known methods.

## References

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