**Assessment of the Load-Bearing Capacity of Automobile Reinforced Concrete Bridges using Midas Civil Software**

Fakhriddin Zokirova), Gulchekhra Ismailova, Mukhabbat Kazakbayeva

*Tashkent State Transport University, Tashkent, Uzbekistan*

*a)Corresponding author: 0202031@inbox.ru*

**Abstract.** This article presents the results of a study aimed at evaluating the load-carrying capacity of an intermediate device of an overpass. During the research, engineering calculations were performed using the Midas Civil DT program, and the obtained results were compared. This process has become important in determining the device's compliance with regulatory requirements. The resistance of the intermediate device to longitudinal cracks under the influence of permanent and temporary load was also evaluated. This study helped to determine how the device behaves under different loads, to identify areas where cracks may appear, and to study their effects. The results serve as a basis for making effective decisions in the processes of ensuring the safety of structures and repairing them. Such analyzes serve as an important source of information for future research and practical work, as they help to increase the reliability of the device and extend its operational life.

**Keywords**: Bending moment, reinforcement, transient loads, boundary conditions, stresses, intermediate device, bearing capacity.

**INTRODUCTION**

Midas Civil is a modern software widely used in the field of engineering and construction. Midas Civil is primarily used for analyzing and calculating the structure and dynamics of buildings, as well as assessing their load-bearing capacity. The software is developed based on a range of advanced technologies aimed at simplifying the structural analysis and simulation processes. One of the key features of Midas Civil DT is its ability to create 2D and 3D models of structures, allowing for better visualization of the projects [1, 3]. Additionally, Midas Civil software (DT) is designed for modeling and computational analysis of transportation structures, construction objects for various purposes, as well as for designing structural elements and assessing their load-bearing capacity. Midas Civil sets a new standard for engineering software used in bridge and civil infrastructure design.

The software has a user-friendly interface and offers a wide range of functions for design, including everything from creating databases to solving nonlinear problems. Its highly developed tools for modeling and computational analysis help address common challenges encountered during the calculation of structures, supported by the integration of CHEU (Complex Hydraulic and Environmental Units). This makes Midas Civil a powerful tool for overcoming the general issues faced in structural analysis [2, 4-5].

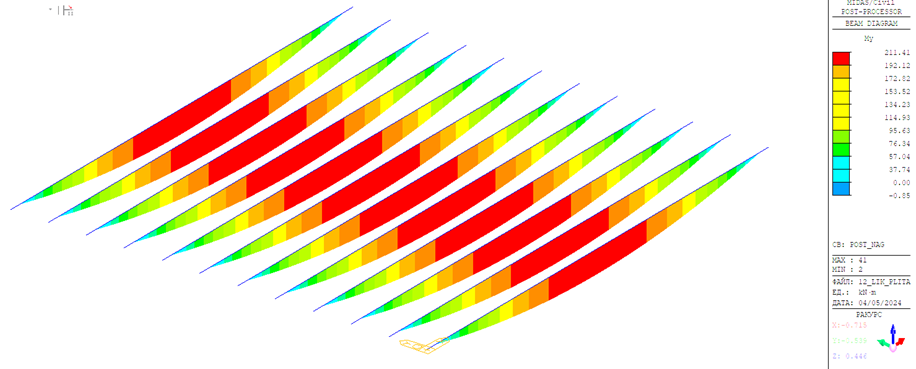
**MATERIALS AND METHODS**

We will calculate the load-bearing capacity of the reinforced concrete automobile bridge deck located at the PK137+84.80 section of the 4R105 “Darband – Boysun – Elbayon” automobile road. For this, the intermediate structure models will be created using “Beam” type prestressed elements in Midas Civil DT (see Fig 1).

|  |  |
| --- | --- |
|  |  |
| a) | b) |

**FIGURE 1.** Reinforced Concrete Automobile Bridge Deck at PK137+84.80 section of the 4R105 “Darband – Boysun – Elbayon” Automobile Road: a) Cross-section of the bridge deck; b) Model Created Using Midas Civil DT

Temporary loads specified in the QMQ 2.05.03-97 “Bridges and Pipes” standard will be applied to the created sample model. Because of the loading, we will determine the values of the bending moments generated under the influence of both permanent and temporary loads in the sample model, as well as the stresses occurring in the lower part of the intermediate structure (see Fig. 2-3).



**FIGURE 2.** Bending moment diagram resulting from permanent loads in the intermediate structure

|  |  |
| --- | --- |
|  |  |
| a) | b) |

**FIGURE 3.** Bending moment diagram resulting from temporary loads in the intermediate structure: a)temporary Loads A11; b) temporary Loads NK-80

After determining the bending moment values resulting from both permanent and temporary loads, the interaction dynamics of these loads are then formulated.

Additionally, using the Midas Civil software, we select the type of analysis (static or dynamic) to investigate the strength and deformation state of the model, define the material properties for all structural elements, and set the boundary conditions for simulating the real-life conditions (stability and durability). Once the boundary conditions are established, the load types (A11 or NK80) are selected, and a system analysis is performed in Midas Civil DT using the specified load combinations [1, 6-8]. This means that the software calculates the strength and deformation states of the elements at various points along the structure of the bridge deck, as well as the corresponding bending moment values (see Fig. 4).

Moreover, the comprehensive integration of Midas Civil DT with Eurocodes (EN 1991, EN 1992, EN 1993, and EN 1997) allows for simulation-based analysis of the load-bearing capacity of reinforced concrete bridge decks in operational automobile road infrastructure, in accordance with international standards.

|  |  |
| --- | --- |
|  |  |
| a) | b) |

**FIGURE 4.** Stresses resulting from permanent and temporary loads in the lower part of the intermediate structure: a)permanent and temporary loads (A11); b) permanent and temporary loads (NK80

From the figures above, we can observe that the bending moment value resulting from permanent loads is 211.41 kNm. Additionally, the bending moment values under the influence of temporary loads (A11 and NK80) are 175.79 kNm and 257.52 kNm, respectively.

As a result, the combined bending moment values under the effect of both permanent and temporary loads are as follows:

For permanent load and A11: 387.2 kNm

For permanent load and NK80: 468.93 kNm.

At this point, to ensure the reliability of the Midas Civil DT results, it is necessary to conduct a series of engineering calculations and compare the results with each other.

To do this, initially, the values of the critical buckling (KQK) are determined using the generalized method of eccentric compression, taking into account the torsion caused by the effect of the temporary load. Then, the intermediate structure is divided into sections along its length, and the bending moment values resulting from both permanent and temporary loads are calculated using the following formulas:

**RESULTS AND DISCUSSION**

These formulas will help to evaluate the bending moment distribution along the length of the intermediate structure under the influence of both types of loads.

 (1)

 (2)

A-11 type vehicles are used to determine the normative and design loads from road transport. The critical buckling (KQK) is calculated using the following formula:

 (3)

Share of temporary load applied to the analyzed intermediate structure

 (4)

 (5)

 (6)

 (7)

Cross-sectional force due to temporary load 𝑃1 and load from vehicle 𝑉1

 (8)

 (9)

 (10)

Resulting Bending Moment Value Due to Temporary Load 𝑃1 and load from vehicle 𝑉1

 (11)

 (12)

The transverse force and bending moment values generated in the intermediate device under the influence of temporary calculated loads are calculated as follows:

 (13)

 (14)

 (15)

After determining the values of the bending moment resulting from permanent and temporary loads, they are recorded in a special record table (see Table 1).

**TABLE 1.** Bending moment values

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **№** | **Permanent normative load** | | **Normative temporary load (A11)** | | **Normal temporary cargo (NK80)** | |
| **Q** | **M** | **V (kN)** | **M (kNm)** | **V (kN)** | **M (kNm)** |
| **1** | 75,20 | 0,00 | 65,18 | 0,00 | 111,25 | 0,00 |
| **2** | 72,56 | 14,78 | 63,71 | 12,79 | 108,93 | 21,79 |
| **3** | 65,96 | 49,40 | 60,03 | 42,67 | 103,13 | 72,19 |
| **4** | 59,36 | 80,74 | 56,34 | 69,54 | 97,34 | 116,81 |
| **5** | 52,77 | 108,77 | 52,66 | 93,39 | 91,55 | 155,63 |
| **6** | 46,17 | 133,50 | 48,98 | 114,23 | 85,75 | 188,65 |
| **7** | 39,58 | 154,94 | 45,30 | 132,05 | 79,96 | 215,89 |
| **8** | 32,98 | 173,08 | 41,62 | 146,87 | 74,16 | 237,32 |
| **9** | 26,38 | 187,92 | 37,94 | 158,67 | 68,37 | 252,97 |
| **10** | 19,79 | 199,47 | 34,26 | 167,45 | 62,58 | 262,82 |
| **11** | 13,19 | 207,71 | 30,58 | 173,23 | 56,78 | 266,87 |
| **12** | 6,60 | 212,66 | 26,89 | 175,99 | 50,99 | 265,14 |
| **13** | 0,00 | 214,31 | 23,21 | 175,74 | 45,19 | 257,60 |

|  |  |
| --- | --- |
|  |  |
| a) | b) |

**FIGURE 5.** Curves of bending moment and transverse force caused by permanent and temporary loads: a)Bending moment; b) Transverse force

From the results shown in Fig. 5 and table 1, it is evident that the theoretical analysis indicates the bending moment value resulting from permanent loads for a 12-meter long standardized intermediate structure is 214.31 kNm. This value demonstrates that the intermediate structure meets the regulatory requirements and can reliably function under permanent loads.

Under the influence of temporary loads, such as A11 and NK80 loads, the resulting bending moments were 175.74 kNm and 257.60 kNm, respectively. These results demonstrate how the effect of temporary loads on the intermediate structure changes and how it behaves under temporary loads. As a result, the total bending moment values under the combined effect of permanent and temporary loads were determined to be 390.05 kNm for the combination of permanent load and A11, and 471.91 kNm for the combination of permanent load and NK80. This provides a broader understanding of how the structure behaves under different load conditions.

The comparison results, as well as the findings from this study, indicate a reliability level of 98.6-99.5% accuracy (see Table 2). This figure demonstrates the high quality and precision of the conducted theoretical analyses and also serves as a crucial foundation for future practical work.

**TABLE 2.** Comparison of Midas Civil DT results with engineering calculations

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **№** | **Midas Civil DT results** | | | **Engineering calculation results** | | |
| **Permanent load** | **Temporary load (A11)** | **Temporary load (NK80)** | **Permanent load** | **Temporary load (A11)** | **Temporary load (NK80)** |
| **1** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **2** | 211.41 | 175.79 | 257.52 | 214.31 | 175.74 | 257.60 |

Based on these determined values, 4R105 “Darband w. - Boysun city. - Elbayon w.” we check the intermediate device of the automobile reinforced concrete overpass located on the PK137+84.80 section of the highway according to two groups of boundary conditions.

The first group is based on the limit state bending strength

 (16)

 (17)

 (18)

**TABLE 3.** Height of compressed area (x)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **№** | **Neutral axis (mm)** | **Compressive force (C), (kN)** | | **Tensile force (T) (kN)** | **Ratio (C/T)** |
| **Concrete** | **Armature** | **Armature** |
| **1** | 315,0 | 2910,7 | 0,0 | 0,0 | 2,737 |
| **2** | 157,5 | 2181,0 | 0,0 | 0,0 | 2,042 |
| **3** | 78,8 | 1295,4 | 0,0 | 0,0 | 1,213 |
| **4** | 39,4 | 647,7 | 0,0 | 0,0 | 0,606 |
| **5** | 59,1 | 971,6 | 0,0 | 0,0 | 0,910 |
| **6** | 68,9 | 1133,5 | 0,0 | 0,0 | 1,061 |
| **7** | 64,0 | 1052,5 | 0,0 | 0,0 | 0,985 |
| **8** | 66,4 | 1093,0 | 0,0 | 0,0 | 1,023 |
| **9** | 65,2 | 1072,8 | 0,0 | 0,0 | 1,004 |
| **10** | 64,6 | 1062,7 | 0,0 | 0,0 | 0,995 |
| **11** | 64,9 | 1067,7 | 0,0 | 0,0 | 1,000 |

The second group is based on the limit state resistance to longitudinal cracks

 (19)

 (20)

**CONCLUSION**

The results of the research aimed at assessing the load-bearing capacity of the reinforced concrete automobile bridge deck at the PK137+84.80 section of the 4R105 “Darband – Boysun – Elbayon” automobile road showed that the structure is capable of withstanding the temporary loads specified in the ShNK 2.05.03-12 “Bridges and Pipes” standard.

This, in turn, ensures that the reinforced concrete deck can continue to operate effectively and safely under a range of operational conditions, including the impact of temporary loads. The findings also allowed for the evaluation of the stress and deformation levels of the existing structure, which is crucial for planning future repair or reinforcement works.

**REFERENCES**

1. Raupov, C., Karimova, A., Zokirov, F., & Khakimova, Y. (2021). Experimental and theoretical assessment of the long-term strength of lightweight concrete and its components under compression and tension, taking into account the macrostructure of the material. *E3S Web of Conferences, 264*, 02024. <https://doi.org/10.1051/e3sconf/202126402024>
2. Salikhanov, S., Pulatova, Z., Zakirov, F., Rahimjonov, Z., & Abdullayev, A. (2021). Determination of deformations and self-stress in concrete on stress cement. *E3S Web of Conferences, 264*, 02056. <https://doi.org/10.1051/e3sconf/202126402056>
3. Shermukhamedov, U., Karimova, A., Abdullaev, A., & Hikmatova, I. (2023). Calculation of monolithic bridges taking into account seismic conditions of Republic of Uzbekistan. *E3S Web of Conferences, 365*, 02005. <https://doi.org/10.1051/e3sconf/202336502005>
4. Shermuxamedov, U., & Shaumarov, S. (2019). Impact of configuration errors on the dynamic oscillation absorbers effectiveness of different masses on the seismic resistance of bridges. *E3S Web of Conferences, 97*, 03017. <https://doi.org/10.1051/e3sconf/20199703017>
5. Avezov, S., Yunusova, D., Yusupjonov, O., Kazakbaeva, M., Gulmurzaeva, R., Saksonov, U., Ruzikulova, O., & Djumabaeva, S. (2024). Quantifying Water Bodies with Sentinel-2 Imagery and NDWI: A Remote Sensing Approach. *E3S Web of Conferences, 590*, 02007. <https://doi.org/10.1051/e3sconf/202459002007>