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Temperature effect to soil ground and structures in transportation engineering

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ABSTRACT: The temperature effects on foundations and structures. The results of calculations of ground bases and structures on temperature influences and loads are given. Conclusions on the obtained results with suggested recommendations are also made in work.

Keywords: temperature, numerical analysis, mosaics, loads

1 INTRODUCTION

Kazakhstan is located in a climatic region with seasonally frozen ground. During the calendar year the temperature varies seasonally from negative to positive values. Temperatures can reach -45 °C in winter and +45 °C in summer. Soil types vary across Kazakhstan due to its large size and varied landscape (Shakhmov et al. 2015; Zhussupbekov at al. 2013; Zhussupbekov at al, 2012; Shakhmov et al. 2016). Many buildings and constructions have been built in Kazakhstan due to urban growth, such as Astana, Almaty and Shymkent. There are also many infrastructure projects such as roads, railways and bridges. Kazakhstan is located at the crossroads between east and west, and historical economic and cultural ties run through this area. Kazakhstan is also a participant in international infrastructure projects such as the Silk Road, One Belt, One Road, and others. The China-Western Europe Westward Project, also known as the New Silk Road by land, is a Chinese initiative to create a network of transport and logistics links between China and Western Europe. One element of this project is the construction of a road that will connect the western and eastern parts of Kazakhstan. The road will be made of cement concrete, which is one of the strongest materials for road construction. It has a high compressive and bending strength which allows it to withstand heavy loads and retain its properties for a long time (Usenov et al. 2022; Kuvakov et al. 2016). But the operation of these rigid roads has resulted in problems with the occurrence of deformation and defects. Defects and deformations such as longitudinal and transverse cracks, through and surface cracks, spalling and warping(blow-up) of boards are common on the road.

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2 RESEARCH METHOD

2.1 *Numerical analysis of various temperature stress-strain state of highways in the "Lira" program*

The LIRA-CAD 2017 software package (LIRA-CAD 2017 PC) is a multifunctional software package for calculating, researching and designing structures for various purposes.

PC LIRA-CAD 2017 is successfully used in the calculations of construction, mechanical engineering, bridge construction, nuclear power, oil industry and in many other areas where methods of construction mechanics are relevant.

The software complexes of the LIRA family have a more than 40-year history of creation, development and application in scientific research and practice of design of structures. The software systems of the LIRA family are continuously being improved and adapted to new operating systems and graphical environments. The newest representative of the LIRA family is the LIRA-CAD 2017 PC.

In addition to the general calculation of the object model for all possible types of static loads, temperature, deformation and dynamic effects (wind taking into account pulsation, seismic effects, etc.), the LIRA-CAD 2017 PC automates a number of design processes: determination of calculated combinations of loads and forces, assignment of structural elements, selection and verification of sections of steel and reinforced concrete structures with the formation of sketches of working drawings of columns and beams.

PC LIRA-CAD 2017 allows you to study the overall stability of the calculated model, check the strength of the cross-sections of elements according to various theories of destruction. The LIRA-CAD 2017 PC provides an opportunity to perform calculations of objects taking into account physical and geometric nonlinearities, to simulate the process of erecting a structure taking into account the installation and dismantling of elements.

PC LIRA-CAD 2017 supports information communication with such systems as AutoCAD,ArchiCAD, Allplan, Hypersteel, as well as PC MONOMACH-CAD, FOC-PC.the template file B1ProcA4.dot to the template directory. This directory can be found by selecting the Tools menu, Options and then by tabbing the File Locations. When the Word programme has been started, open the File menu and choose New. Now select the template B1PROCA4. dot and start by renaming the document after clicking Save As in the Files menu.

2.2 *Initial data*

The road was originally taken from the southern regions of Kazakhstan. This region has the highest temperatures in summer. This causes the concrete slabs to warp. In particular, dozens of cases of road warping are recorded every year in these regions. The road consists of 4 lanes of which 2 in the forward direction and 2 in the reverse direction. The slabs are 5 metres long and 25 cm thick.

3 RESULTS

The results for temperature phenomena at 50 degrees Celsius are shown below.

4 CONCLUSION

According to the results obtained on the temperature loads of the central bank of the plates, isofields and VAT plots were identified with the following values: the expansion of concrete by 50 m was 30 mm, while the deformation of the plates during warping was 92 mm. The maximum mosaics voltage according to Mx 1.93e-009 t* m/ m, according to Mu 105 t * m/ m. When pinched on both sides, the maximum mosaics are stressed by Mx 184 t * m/m,

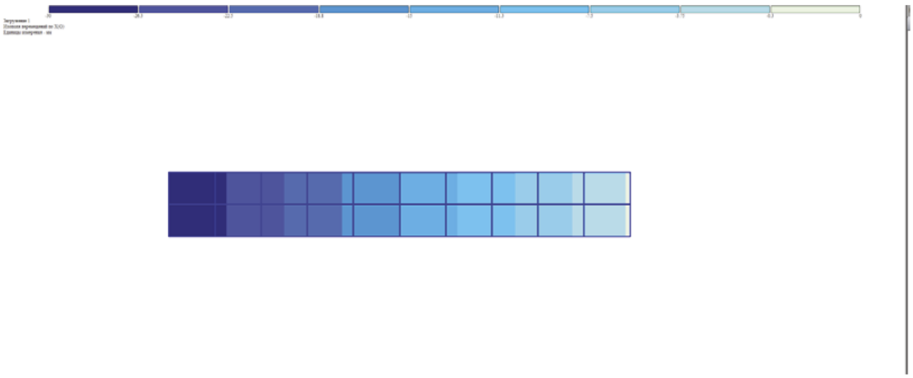

Figure 1. Isofield of movements along the X axis (mm).

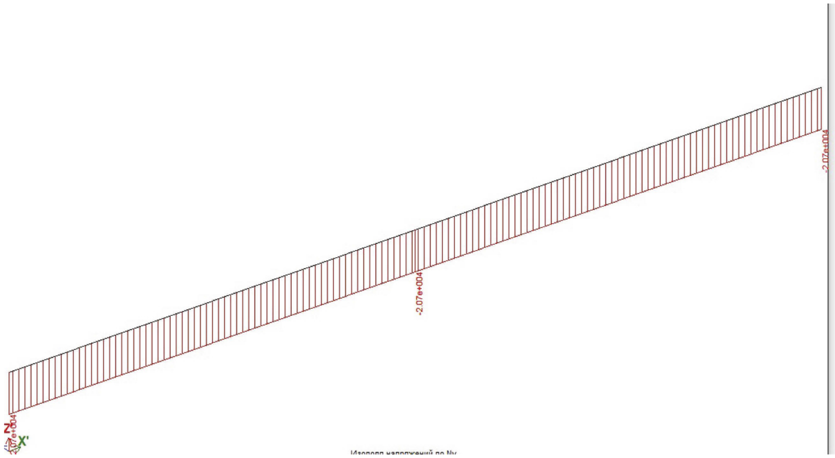

Figure 2. Mx plot.

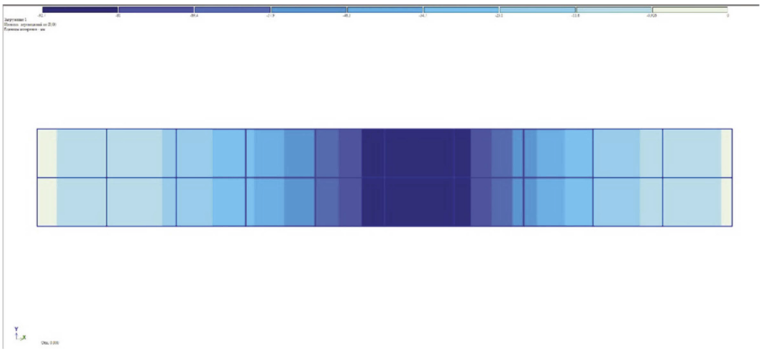

Figure 3. Isofield of movements along the X-axis (mm) with double pinching.

by Mu 231 t * m/m. The mosaic voltage according to Nx is 2.07e-004, and 4.57e-004 (t/m2) with double pinching (Figures 1–10).

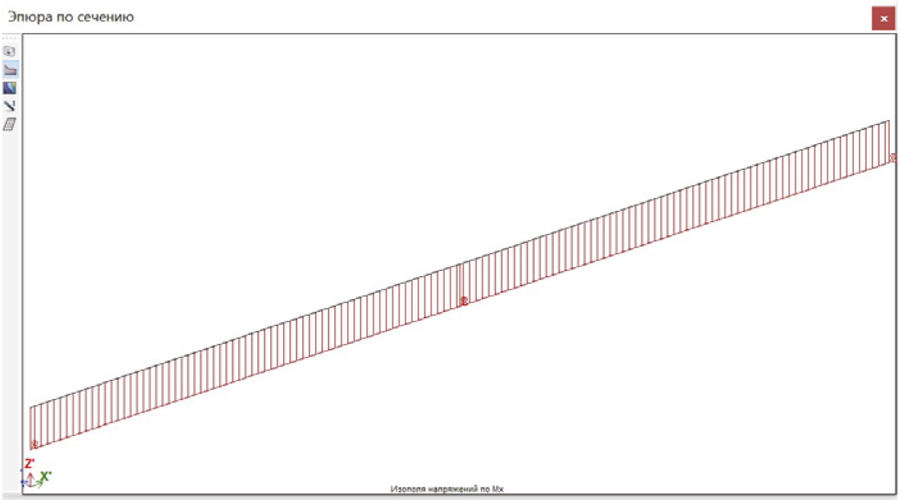

Figure 4. Mx plot.

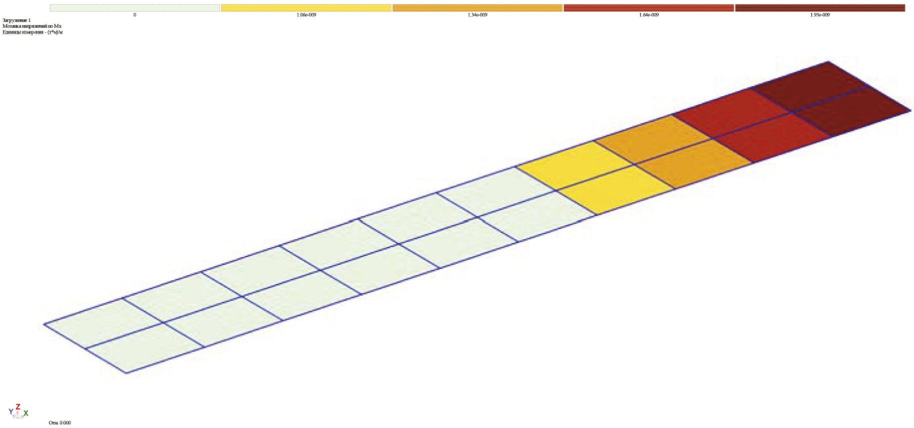

Figure 5. Mosaic voltage by Mx (t*m/m).

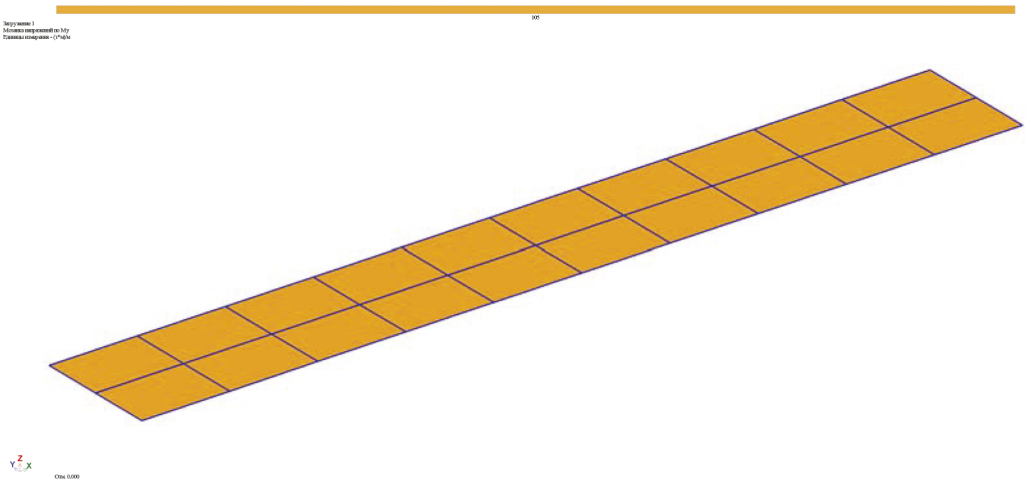

Figure 6. Mosaic of Mu stresses (t*m/m).

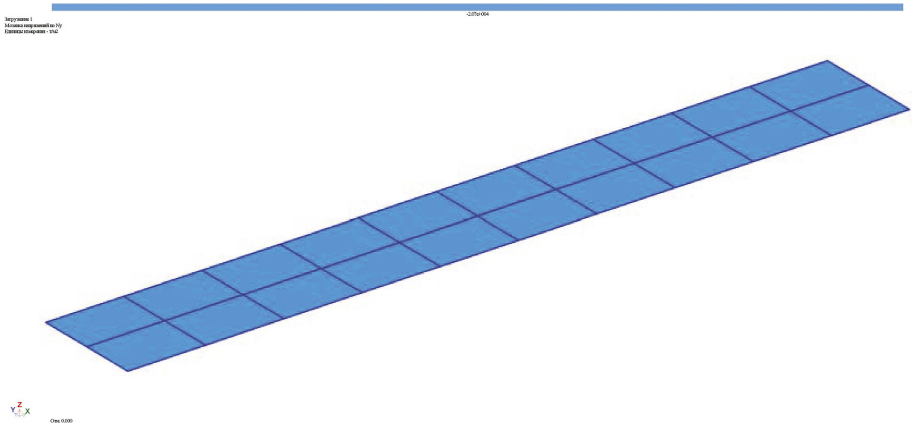

Figure 7. Mosaic of stresses by N (t/m^2).

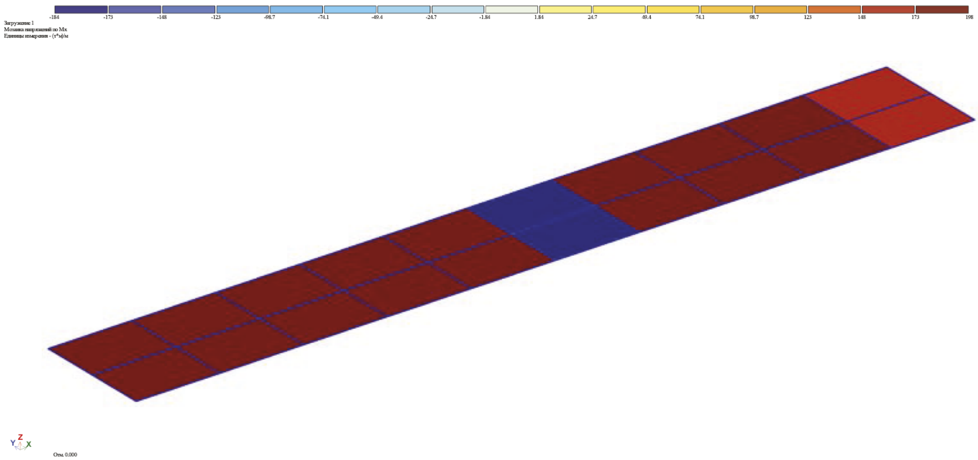

Figure 8. Mosaic voltage according to Mx (t*m/m) 184 pinching on both sides.

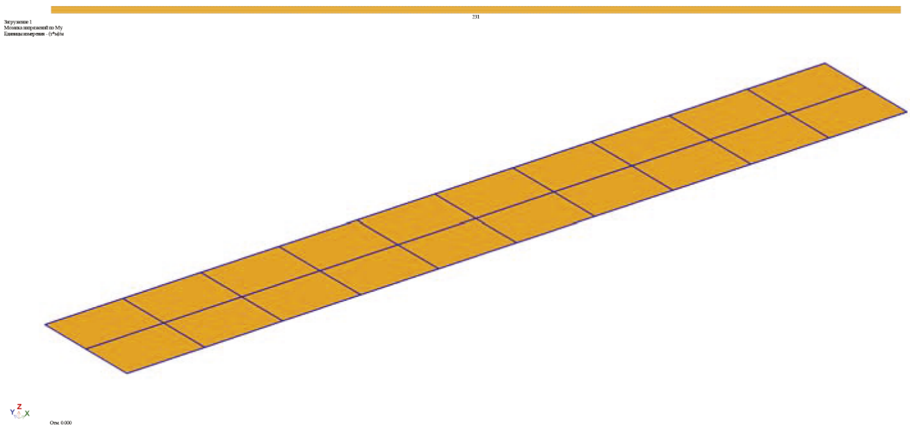

Figure 9. Mosaic of Mu stresses (t*m/m) with pinching on both sides.

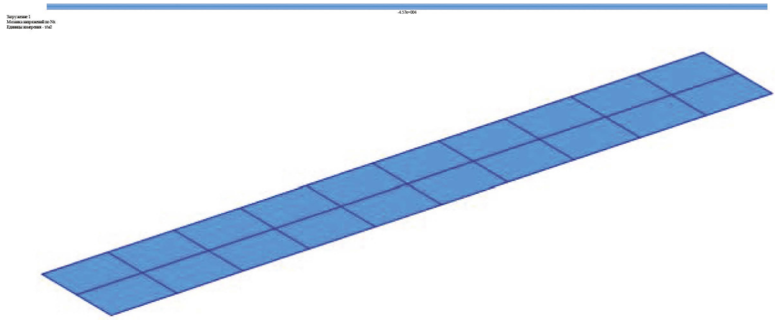

Figure 10. Mosaic of stresses by N (t/m^2).

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