Finite Element Analysis of Flat Slab with Calcpad

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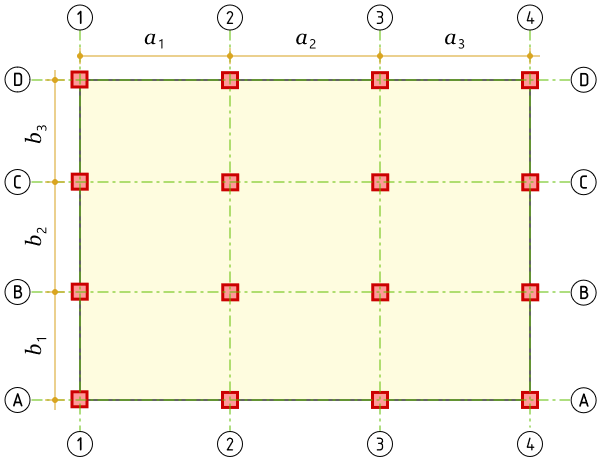
Using Bogner-Fox-Schmit (BFS) plate element [1]

Input data

Span lengths

m , m

Number of axes - ,



Axis coordinates - m, m

Slab dimensions - m, m

Thickness - m Load - kN/m²

Modulus of elasticity - MPa Poisson`s ratio -

Finite element mesh

We will use BFS rectangular finite element with

Element dimensions - m, m

Number of elements and joints along *a* and *b*

, ,

, ,

Total number of elements -

Total number of joints -

Supported joints count -

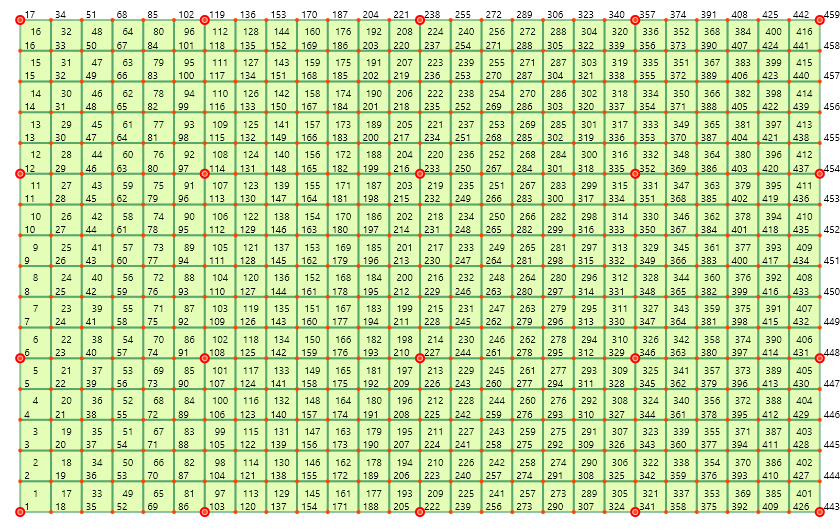
Joint coordinates

m , m

Numbers of joints at elements' corners

Supported joints -

Joints for element e -



Finite element formulation

**Shape functions**

Along dimension *a*

|  |  |  |
| --- | --- | --- |
| Base functions | First derivatives | Second derivatives |

Along dimension *b*

|  |  |  |  |
| --- | --- | --- | --- |
| Base functions | First derivatives | | Second derivatives |
| For vertical displacements | For rotations *θ*ₓ | | For rotations *θ*ᵧ |
| For twist ψ |  | | |
| *N*1,w shape function plot  Картина, която съдържа екранна снимка, цветност, Електриково синьо  Генерираното от ИИ съдържание може да е неправилно. | | *N*1,θx shape function plot  Картина, която съдържа екранна снимка, цветност  Генерираното от ИИ съдържание може да е неправилно. | |
| Картина, която съдържа екранна снимка, Графика, дизайн  Генерираното от ИИ съдържание може да е неправилно. | | Картина, която съдържа екранна снимка, Графика, дизайн  Генерираното от ИИ съдържание може да е неправилно. | |

Shape functions vector

**Constitutive matrix** (stress - strain relationship)

kNm

**Strain-displacement matrix**

The coefficients of the stiffness matrix will be calculated by using the equation

**Element stiffness matrix – numerical evaluation**

Element load vector

kN

Solution

Global stiffness matrix

Global load vector

kN

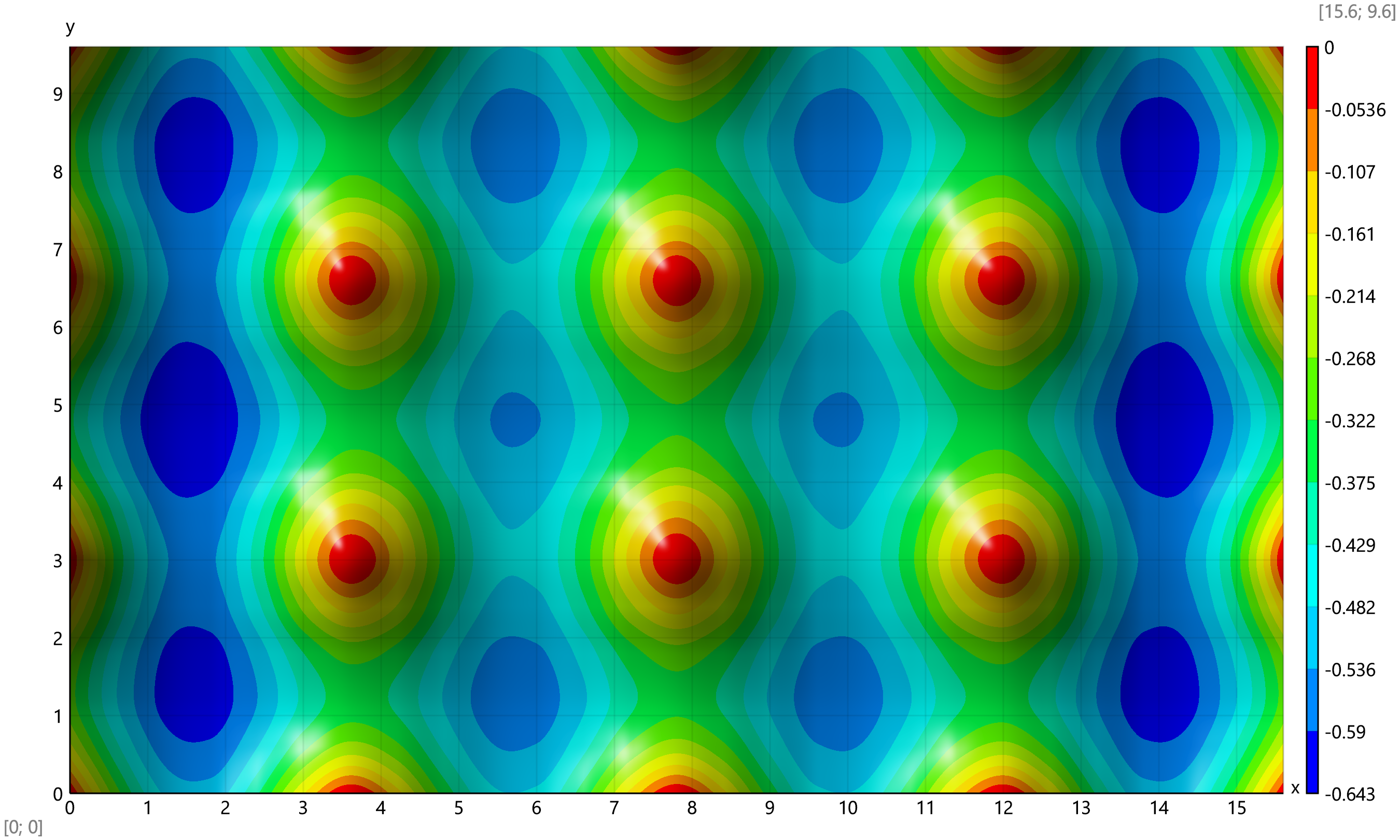
Solution of the system of equations

mm

Results

Joint displacements –

mm



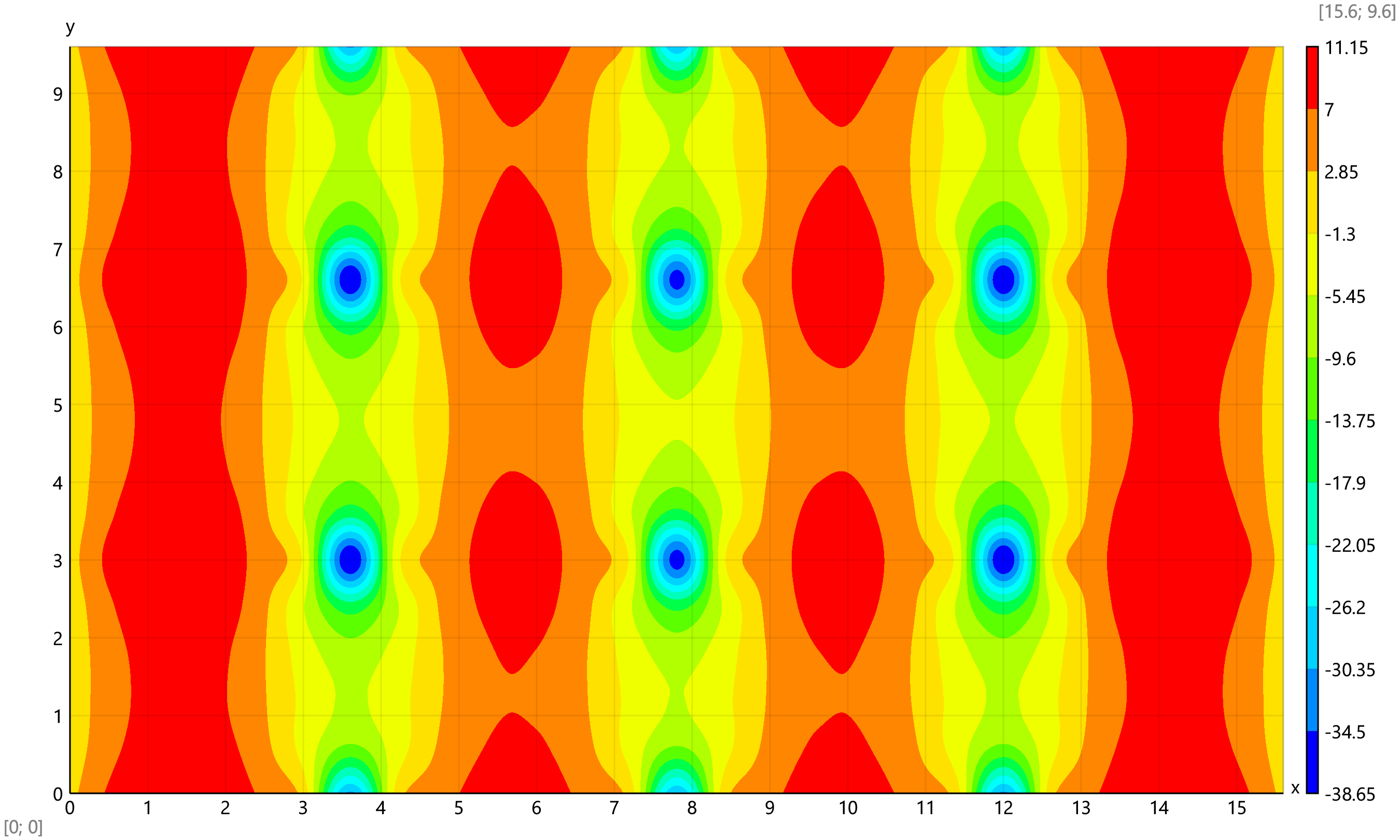
Bending moments

Average bending moments at joints, kNm/m

Bending moments for the plate

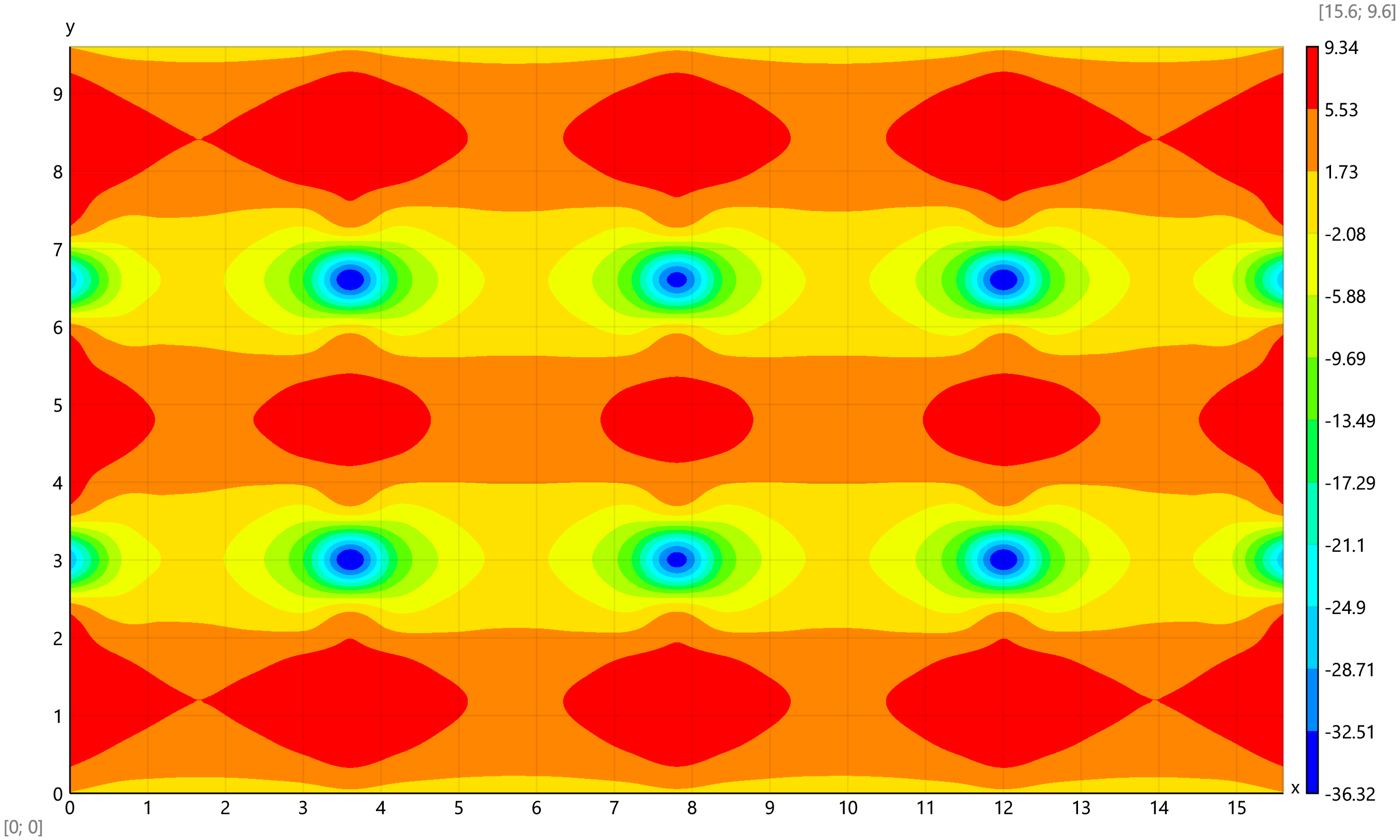
Bending moments - *M*x -

kNm/m



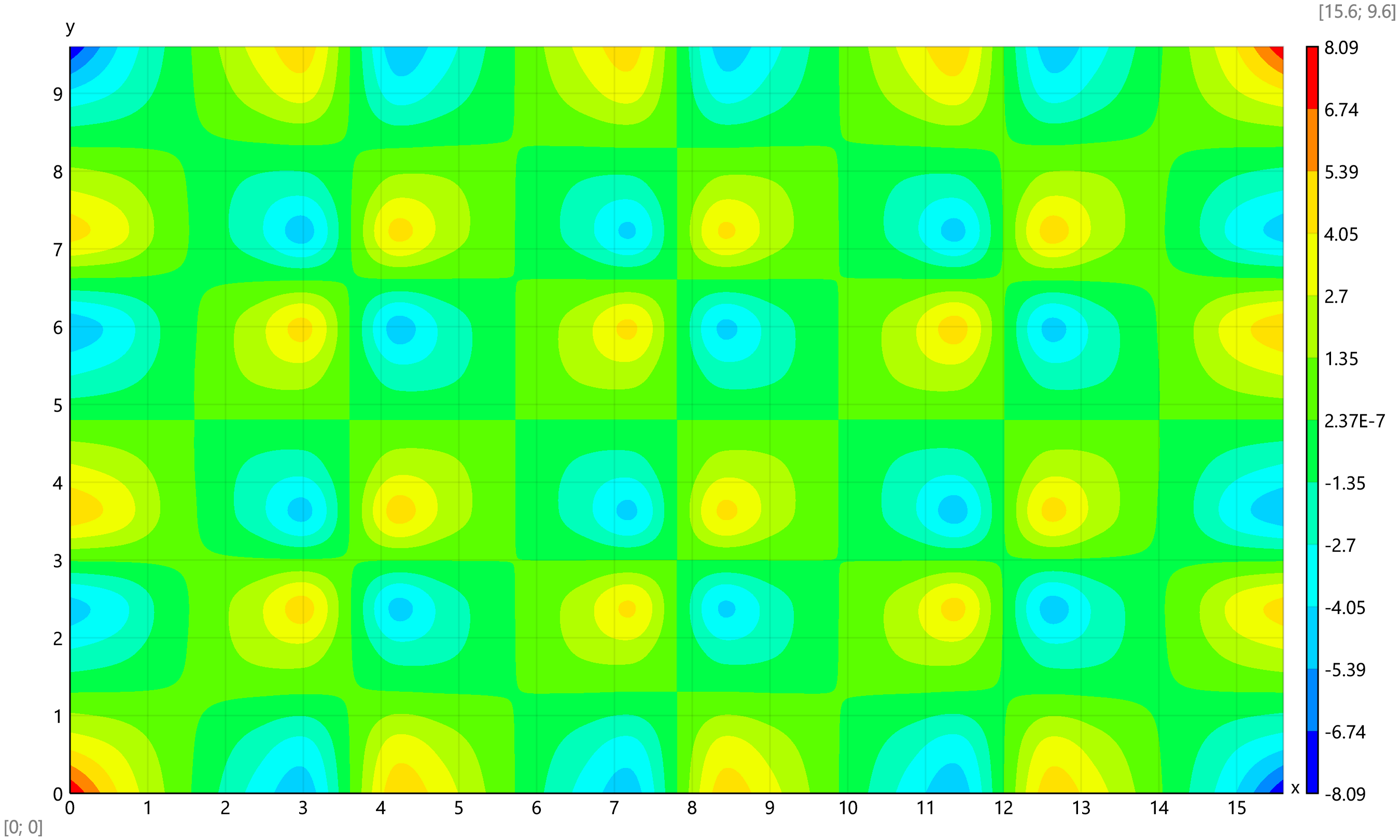
Bending moments *M*y –

kNm/m



Bending moments *M*xy –

kNm/m



 Element stiffness matrix calculation by analytical expressions (faster)

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Element stiffness matrix coefficients (above the main diagonal only)

**Element load vector**

kN

The obtained element stiffness matrix and load vector are identical to the numerical formulation.

[1] Bogner, F. K., Fox, R. L., and Schmit, L. A. The generation of interelement compatible stiffness and mass matrices by the use of interpolation formulae, Proceedings of the Conference on Matrix Methods in Structural Mechanics, 397–444, 1965