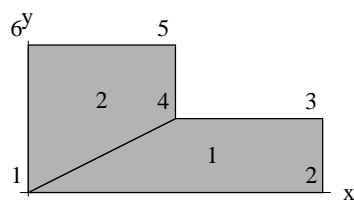
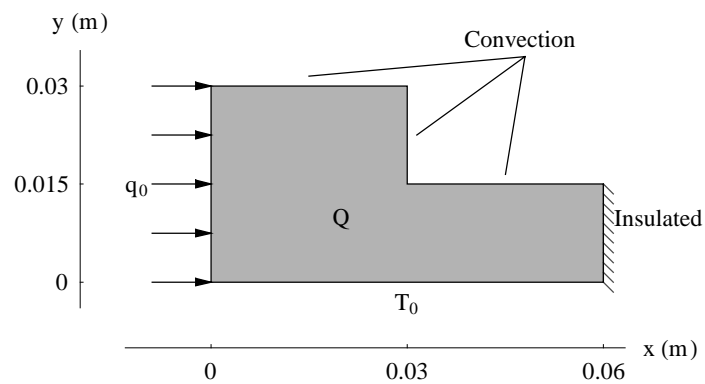


Example 9.7: Heat flow in an L-shaped body (p. 624)

Consider two dimensional heat flow over an L-shaped body with thermal conductivity $k = 45 \text{ W/m} \cdot ^\circ\text{C}$ shown in Figure. The bottom is maintained at $T_0 = 110^\circ\text{C}$. Convection heat loss takes place on the top where the ambient air temperature is 20°C and the convection heat transfer coefficient is $h = 55 \text{ W/m}^2 \cdot ^\circ\text{C}$. The right side is insulated. The left side is subjected to heat flux at a uniform rate of $q_L = 8000 \text{ W/m}^2$. Heat is generated in the body at a rate of $Q = 5 \times 10^6 \text{ W/m}^3$. Determine temperature distribution in the body.



With $n = 2$ the finite element solution is as follows.

Interpolation functions for mapping: $\left\{ \frac{1}{4} (1-s)(1-t), \frac{1}{4} (s+1)(1-t), \frac{1}{4} (s+1)(t+1), \frac{1}{4} (1-s)(t+1) \right\}$

Interpolation functions for assumed solution: $N^T = \left\{ \frac{1}{4} (1-s)(1-t), \frac{1}{4} (s+1)(1-t), \frac{1}{4} (s+1)(t+1), \right.$

$$\left. \frac{1}{4} (1-s)(t+1), \frac{\left(\frac{3s^2}{2} - \frac{3}{2}\right)(1-t)}{2\sqrt{6}}, \frac{(s+1)\left(\frac{3t^2}{2} - \frac{3}{2}\right)}{2\sqrt{6}}, \frac{\left(\frac{3s^2}{2} - \frac{3}{2}\right)(t+1)}{2\sqrt{6}}, \frac{(1-s)\left(\frac{3t^2}{2} - \frac{3}{2}\right)}{2\sqrt{6}} \right\}$$

$$\partial N^T / \partial s = \left\{ \frac{t-1}{4}, \frac{1-t}{4}, \frac{t+1}{4}, \frac{1}{4} (-t-1), \frac{1}{2} \sqrt{\frac{3}{2}} s (1-t), \frac{\frac{3t^2}{2} - \frac{3}{2}}{2\sqrt{6}}, \frac{1}{2} \sqrt{\frac{3}{2}} s (t+1), -\frac{\frac{3t^2}{2} - \frac{3}{2}}{2\sqrt{6}} \right\}$$

$$\partial N^T / \partial t = \left\{ \frac{s-1}{4}, \frac{1}{4} (-s-1), \frac{s+1}{4}, \frac{1-s}{4}, -\frac{\frac{3s^2}{2} - \frac{3}{2}}{2\sqrt{6}}, \frac{1}{2} \sqrt{\frac{3}{2}} (s+1)t, \frac{\frac{3s^2}{2} - \frac{3}{2}}{2\sqrt{6}}, \frac{1}{2} \sqrt{\frac{3}{2}} (1-s)t \right\}$$

Use 2x2 Gauss quadrature for integration.

Global equations at start of the element assembly process

$$\begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} T_1 \\ T_2 \\ T_3 \\ T_4 \\ T_5 \\ T_6 \\ \delta_1^{(1,2)} \\ \delta_1^{(1,4)} \\ \delta_1^{(1,6)} \\ \delta_1^{(2,3)} \\ \delta_1^{(3,4)} \\ \delta_1^{(4,5)} \\ \delta_1^{(5,6)} \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}$$

Equations for element 1

Element coordinates: ({0, 0} {0.06, 0} {0.06, 0.015} {0.03, 0.015})

$$x(s,t) = -0.0075 t s + 0.0225 s + 0.0075 t + 0.0375$$

$$y(s,t) = 0.0075 t + 0.0075$$

$$\mathbf{J} = \begin{pmatrix} 0.0225 - 0.0075 t & 0.0075 - 0.0075 s \\ 0 & 0.0075 \end{pmatrix}$$

$$\det \mathbf{J} = 0.00016875 - 0.00005625 t$$

Given element data

$$k_x = 45 \quad k_y = 45 \quad p = 0 \quad q = 5000000$$

Element data in mapped coordinates

$$k_x = 45 \quad k_y = 45 \quad p = 0 \quad q = 5000000$$

$$\text{Gauss point} = \{s \rightarrow -0.57735, t \rightarrow -0.57735\} \quad \text{Weight} = 1.$$

$$\mathbf{N}^T = \{0.622008, 0.166667, 0.0446582, 0.166667, -0.321975, -0.086273, -0.086273, -0.321975\}$$

$$\partial \mathbf{N}^T / \partial s =$$

$$(-0.394338 \quad 0.394338 \quad 0.105662 \quad -0.105662 \quad -0.557678 \quad -0.204124 \quad -0.149429 \quad 0.204124)$$

$$\partial \mathbf{N}^T / \partial t =$$

$$(-0.394338 \quad -0.105662 \quad 0.105662 \quad 0.394338 \quad 0.204124 \quad -0.149429 \quad -0.204124 \quad -0.557678)$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 37.2715 & 0. \\ -58.7903 & 133.333 \end{pmatrix} \quad \det \mathbf{J} = 0.000201226$$

$$\mathbf{B}^T = \begin{pmatrix} -14.6976 & 14.6976 & 3.9382 & -3.9382 & -20.7855 & -7.60802 & -5.56946 & 7.60802 \\ -29.3951 & -37.2715 & 7.8764 & 58.7903 & 60.0026 & -7.92339 & -18.4316 & -86.3575 \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$\mathbf{k}_k =$$

$$\begin{pmatrix} 9.78042 & 7.96477 & -2.62065 & -15.1245 & -13.205 & 3.12157 & 5.64731 & 21.9739 \\ 7.96477 & 14.5352 & -2.13415 & -20.3658 & -23.0172 & 1.6616 & 5.47942 & 30.1582 \\ -2.62065 & -2.13415 & 0.702202 & 4.05261 & 3.53828 & -0.836423 & -1.51319 & -5.88789 \\ -15.1245 & -20.3658 & 4.05261 & 31.4378 & 32.6839 & -3.94675 & -9.61354 & -46.2442 \\ -13.205 & -23.0172 & 3.53828 & 32.6839 & 36.5136 & -2.87309 & -8.96622 & -48.3529 \\ 3.12157 & 1.6616 & -0.836423 & -3.94675 & -2.87309 & 1.09261 & 1.70611 & 5.67181 \\ 5.64731 & 5.47942 & -1.51319 & -9.61354 & -8.96622 & 1.70611 & 3.35713 & 14.0295 \\ 21.9739 & 30.1582 & -5.88789 & -46.2442 & -48.3529 & 5.67181 & 14.0295 & 68.0541 \end{pmatrix}$$

$$\mathbf{k}_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_q^T = (625.821 \quad 167.688 \quad 44.9319 \quad 167.688 \quad -323.949 \quad -86.8018 \quad -86.8018 \quad -323.949)$$

Gauss point = {s → -0.57735, t → 0.57735} Weight = 1.

$$\mathbf{N}^T = \{0.166667, 0.0446582, 0.166667, 0.622008, -0.086273, -0.086273, -0.321975, -0.321975\}$$

$$\frac{\partial \mathbf{N}^T}{\partial s} =$$

$$(-0.105662 \quad 0.105662 \quad 0.394338 \quad -0.394338 \quad -0.149429 \quad -0.204124 \quad -0.557678 \quad 0.204124)$$

$$\frac{\partial \mathbf{N}^T}{\partial t} =$$

$$(-0.394338 \quad -0.105662 \quad 0.105662 \quad 0.394338 \quad 0.204124 \quad 0.149429 \quad -0.204124 \quad 0.557678)$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 55.0362 & 0. \\ -86.8113 & 133.333 \end{pmatrix} \quad \det \mathbf{J} = 0.000136274$$

$$\mathbf{B}^T = \begin{pmatrix} -5.81525 & 5.81525 & 21.7028 & -21.7028 & -8.22401 & -11.2342 & -30.6924 & 11.2342 \\ -43.4056 & -23.261 & -20.1446 & 86.8113 & 40.1887 & 37.6442 & 21.1962 & 56.6367 \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$\mathbf{k}_k =$$

$$\begin{pmatrix} 11.761 & 5.98419 & 4.58811 & -22.3333 & -10.4041 & -9.61942 & -4.54742 & -15.4761 \\ 5.98419 & 3.52543 & 3.64746 & -13.1571 & -6.02597 & -5.77035 & -4.11804 & -7.67828 \\ 4.58811 & 3.64746 & 5.37694 & -13.6125 & -6.05918 & -6.14547 & -6.70326 & -5.50139 \\ -22.3333 & -13.1571 & -13.6125 & 49.1029 & 22.4892 & 21.5352 & 15.3687 & 28.6557 \\ -10.4041 & -6.02597 & -6.05918 & 22.4892 & 10.3193 & 9.84399 & 6.77169 & 13.3916 \\ -9.61942 & -5.77035 & -6.14547 & 21.5352 & 9.84399 & 9.46398 & 7.00752 & 12.3005 \\ -4.54742 & -4.11804 & -6.70326 & 15.3687 & 6.77169 & 7.00752 & 8.53193 & 5.24729 \\ -15.4761 & -7.67828 & -5.50139 & 28.6557 & 13.3916 & 12.3005 & 5.24729 & 20.4447 \end{pmatrix}$$

$$\mathbf{k}_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_q^T = (113.562 \quad 30.4288 \quad 113.562 \quad 423.818 \quad -58.7839 \quad -58.7839 \quad -219.384 \quad -219.384)$$

Gauss point = {s → 0.57735, t → -0.57735} Weight = 1.

$$\mathbf{N}^T = \{0.166667, 0.622008, 0.166667, 0.0446582, -0.321975, -0.321975, -0.086273, -0.086273\}$$

$$\partial \mathbf{N}^T / \partial s =$$

$$(-0.394338 \quad 0.394338 \quad 0.105662 \quad -0.105662 \quad 0.557678 \quad -0.204124 \quad 0.149429 \quad 0.204124)$$

$$\partial \mathbf{N}^T / \partial t =$$

$$(-0.105662 \quad -0.394338 \quad 0.394338 \quad 0.105662 \quad 0.204124 \quad -0.557678 \quad -0.204124 \quad -0.149429)$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 37.2715 & 0. \\ -15.7528 & 133.333 \end{pmatrix} \quad \det \mathbf{J} = 0.000201226$$

$$\mathbf{B}^T = \begin{pmatrix} -14.6976 & 14.6976 & 3.9382 & -3.9382 & 20.7855 & -7.60802 & 5.56946 & 7.60802 \\ -7.8764 & -58.7903 & 50.9139 & 15.7528 & 18.4316 & -71.1415 & -29.5705 & -23.1394 \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$\mathbf{k}_k =$$

$$\begin{pmatrix} 2.51785 & 2.23696 & -4.15542 & -0.599393 & -4.0809 & 6.08651 & 1.3678 & 0.63781 \\ 2.23696 & 33.2534 & -26.5802 & -8.91023 & -7.04583 & 36.86 & 16.4832 & 13.3309 \\ -4.15542 & -26.5802 & 23.6134 & 7.12213 & 9.2388 & -33.0699 & -13.4344 & -10.3967 \\ -0.599393 & -8.91023 & 7.12213 & 2.38749 & 1.88792 & -9.87661 & -4.41667 & -3.57202 \\ -4.0809 & -7.04583 & 9.2388 & 1.88792 & 6.98841 & -13.3055 & -3.88708 & -2.43004 \\ 6.08651 & 36.86 & -33.0699 & -9.87661 & -13.3055 & 46.3533 & 18.6656 & 14.3822 \\ 1.3678 & 16.4832 & -13.4344 & -4.41667 & -3.88708 & 18.6656 & 8.19884 & 6.57963 \\ 0.63781 & 13.3309 & -10.3967 & -3.57202 & -2.43004 & 14.3822 & 6.57963 & 5.37257 \end{pmatrix}$$

$$\mathbf{k}_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_q^T = (167.688 \quad 625.821 \quad 167.688 \quad 44.9319 \quad -323.949 \quad -323.949 \quad -86.8018 \quad -86.8018)$$

Gauss point = {s → 0.57735, t → 0.57735} Weight = 1.

$$\mathbf{N}^T = \{0.0446582, 0.166667, 0.622008, 0.166667, -0.086273, -0.321975, -0.321975, -0.086273\}$$

$$\partial \mathbf{N}^T / \partial s =$$

$$(-0.105662 \quad 0.105662 \quad 0.394338 \quad -0.394338 \quad 0.149429 \quad -0.204124 \quad 0.557678 \quad 0.204124)$$

$$\partial \mathbf{N}^T / \partial t =$$

$$(-0.105662 \quad -0.394338 \quad 0.394338 \quad 0.105662 \quad 0.204124 \quad 0.557678 \quad -0.204124 \quad 0.149429)$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 55.0362 & 0. \\ -23.261 & 133.333 \end{pmatrix} \quad \det \mathbf{J} = 0.000136274$$

$$\mathbf{B}^T = \begin{pmatrix} -5.81525 & 5.81525 & 21.7028 & -21.7028 & 8.22401 & -11.2342 & 30.6924 & 11.2342 \\ -11.6305 & -55.0362 & 43.4056 & 23.261 & 23.7407 & 79.1051 & -40.1887 & 15.1758 \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$\mathbf{k}_k =$$

$$\begin{pmatrix} 1.03689 & 3.71792 & -3.86973 & -0.88508 & -1.98651 & -5.24132 & 1.77182 & -1.48299 \\ 3.71792 & 18.7821 & -13.8755 & -8.62454 & -7.7192 & -27.0986 & 14.6582 & -4.7212 \\ -3.86973 & -13.8755 & 14.442 & 3.30316 & 7.41377 & 19.5609 & -6.61252 & 5.5346 \\ -0.88508 & -8.62454 & 3.30316 & 6.20646 & 2.29195 & 12.779 & -9.81751 & 0.669587 \\ -1.98651 & -7.7192 & 7.41377 & 2.29195 & 3.87106 & 10.95 & -4.30301 & 2.77594 \\ -5.24132 & -27.0986 & 19.5609 & 12.779 & 10.95 & 39.1478 & -21.61 & 6.5878 \\ 1.77182 & 14.6582 & -6.61252 & -9.81751 & -4.30301 & -21.61 & 15.6813 & -1.62561 \\ -1.48299 & -4.7212 & 5.5346 & 0.669587 & 2.77594 & 6.5878 & -1.62561 & 2.18625 \end{pmatrix}$$

$$\mathbf{k}_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_q^T = (30.4288 \quad 113.562 \quad 423.818 \quad 113.562 \quad -58.7839 \quad -219.384 \quad -219.384 \quad -58.7839)$$

Adding contributions from all Gauss points

$$\mathbf{k}_k =$$

$$\begin{pmatrix} 25.0962 & 19.9038 & -6.05769 & -38.9423 & -29.6765 & -5.65267 & 4.2395 & 5.65267 \\ 19.9038 & 70.0962 & -38.9423 & -51.0577 & -43.8082 & 5.65267 & 32.5028 & 31.0897 \\ -6.05769 & -38.9423 & 44.1346 & 0.865385 & 14.1317 & -20.4909 & -28.2633 & -16.2514 \\ -38.9423 & -51.0577 & 0.865385 & 89.1346 & 59.353 & 20.4909 & -8.479 & -20.4909 \\ -29.6765 & -43.8082 & 14.1317 & 59.353 & 57.6923 & 4.61538 & -10.3846 & -34.6154 \\ -5.65267 & 5.65267 & -20.4909 & 20.4909 & 4.61538 & 96.0577 & 5.76923 & 38.9423 \\ 4.2395 & 32.5028 & -28.2633 & -8.479 & -10.3846 & 5.76923 & 35.7692 & 24.2308 \\ 5.65267 & 31.0897 & -16.2514 & -20.4909 & -34.6154 & 38.9423 & 24.2308 & 96.0577 \end{pmatrix}$$

$$\mathbf{k}_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_q^T = (937.5 \quad 937.5 \quad 750. \quad 750. \quad -765.466 \quad -688.919 \quad -612.372 \quad -688.919)$$

Natural boundary conditions

Specified NBC values for side 3: $\alpha = -55$ $\beta = 1100$

Interpolation functions for mapping: $\{0, 0, \frac{1-a}{2}, \frac{a+1}{2}\}$

Interpolation functions for solution: $\{0, 0, \frac{1-a}{2}, \frac{a+1}{2}, 0, 0, \frac{\frac{3a^2}{2} - \frac{3}{2}}{\sqrt{6}}, 0\}$

$$x(a) = 0.045 - 0.015 a \quad y(a) = 0.015$$

$$J_c = 0.015$$

$$\text{Value in mapped coordinate: } \alpha(a) = -55 \quad \beta(a) = 1100$$

$$\text{Gauss point} = -0.57735 \quad \text{Weight} = 1.$$

$$\mathbf{N}_c^T = \{0., 0., 0.788675, 0.211325, 0., 0., -0.408248, 0.\}$$

$$J_c = 0.015 \quad \alpha = -55. \quad \beta = 1100.$$

$$\mathbf{k}_\alpha = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & -0.513157 & -0.1375 & 0. & 0. & 0.26563 & 0. \\ 0. & 0. & -0.1375 & -0.036843 & 0. & 0. & 0.0711752 & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0.26563 & 0.0711752 & 0. & 0. & -0.1375 & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix} \quad \mathbf{r}_\beta = \begin{pmatrix} 0. \\ 0. \\ -13.0131 \\ -3.48686 \\ 0. \\ 0. \\ 6.7361 \\ 0. \end{pmatrix}$$

$$\text{Gauss point} = 0.57735 \quad \text{Weight} = 1.$$

$$\mathbf{N}_c^T = \{0., 0., 0.211325, 0.788675, 0., 0., -0.408248, 0.\}$$

$$J_c = 0.015 \quad \alpha = -55. \quad \beta = 1100.$$

$$\mathbf{k}_\alpha = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & -0.036843 & -0.1375 & 0. & 0. & 0.0711752 & 0. \\ 0. & 0. & -0.1375 & -0.513157 & 0. & 0. & 0.26563 & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0.0711752 & 0.26563 & 0. & 0. & -0.1375 & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix} \quad \mathbf{r}_\beta = \begin{pmatrix} 0. \\ 0. \\ -3.48686 \\ -13.0131 \\ 0. \\ 0. \\ 6.7361 \\ 0. \end{pmatrix}$$

Adding contributions from all Gauss points

$$\mathbf{k}_\alpha = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & -0.55 & -0.275 & 0. & 0. & 0.336805 & 0. \\ 0. & 0. & -0.275 & -0.55 & 0. & 0. & 0.336805 & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0.336805 & 0.336805 & 0. & 0. & -0.275 & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix} \quad \mathbf{r}_\beta = \begin{pmatrix} 0. \\ 0. \\ -16.5 \\ -16.5 \\ 0. \\ 0. \\ 13.4722 \\ 0. \end{pmatrix}$$

$$\begin{pmatrix} 25.0962 & 19.9038 & -6.05769 & -38.9423 & -29.6765 & -5.65267 & 4.2395 & 5.65267 \\ 19.9038 & 70.0962 & -38.9423 & -51.0577 & -43.8082 & 5.65267 & 32.5028 & 31.0897 \\ -6.05769 & -38.9423 & 43.5846 & 0.590385 & 14.1317 & -20.4909 & -27.9265 & -16.2514 \\ -38.9423 & -51.0577 & 0.590385 & 88.5846 & 59.353 & 20.4909 & -8.1422 & -20.4909 \\ -29.6765 & -43.8082 & 14.1317 & 59.353 & 57.6923 & 4.61538 & -10.3846 & -34.6154 \\ -5.65267 & 5.65267 & -20.4909 & 20.4909 & 4.61538 & 96.0577 & 5.76923 & 38.9423 \\ 4.2395 & 32.5028 & -27.9265 & -8.1422 & -10.3846 & 5.76923 & 35.4942 & 24.2308 \\ 5.65267 & 31.0897 & -16.2514 & -20.4909 & -34.6154 & 38.9423 & 24.2308 & 96.0577 \end{pmatrix}$$

$$\begin{pmatrix} T_1 \\ T_2 \\ T_3 \\ T_4 \\ \delta_1^{(1,2)} \\ \delta_1^{(2,3)} \\ \delta_1^{(3,4)} \\ \delta_1^{(1,4)} \end{pmatrix} = \begin{pmatrix} 937.5 \\ 937.5 \\ 733.5 \\ 733.5 \\ -765.466 \\ -688.919 \\ -598.9 \\ -688.919 \end{pmatrix}$$

Equations for element 2

Element coordinates: ({0, 0} {0.03, 0.015} {0.03, 0.03} {0, 0.03})

$$x(s,t) = 0.015s + 0.015$$

$$y(s,t) = -0.00375ts + 0.00375s + 0.01125t + 0.01875$$

$$\mathbf{J} = \begin{pmatrix} 0.015 & 0 \\ 0.00375 - 0.00375t & 0.01125 - 0.00375s \end{pmatrix}$$

$$\det \mathbf{J} = 0.00016875 - 0.00005625s$$

Given element data

$$k_x = 45 \quad k_y = 45 \quad p = 0 \quad q = 5000000$$

Element data in mapped coordinates

$$k_x = 45 \quad k_y = 45 \quad p = 0 \quad q = 5000000$$

$$\text{Gauss point} = \{s \rightarrow -0.57735, t \rightarrow -0.57735\} \quad \text{Weight} = 1.$$

$$\mathbf{N}^T = \{0.622008, 0.166667, 0.0446582, 0.166667, -0.321975, -0.086273, -0.086273, -0.321975\}$$

$$\frac{\partial \mathbf{N}^T}{\partial s} =$$

$$(-0.394338 \quad 0.394338 \quad 0.105662 \quad -0.105662 \quad -0.557678 \quad -0.204124 \quad -0.149429 \quad 0.204124)$$

$$\frac{\partial \mathbf{N}^T}{\partial t} =$$

$$(-0.394338 \quad -0.105662 \quad 0.105662 \quad 0.394338 \quad 0.204124 \quad -0.149429 \quad -0.204124 \quad -0.557678)$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 66.6667 & -29.3951 \\ 0. & 74.5431 \end{pmatrix} \quad \det \mathbf{J} = 0.000201226$$

$$\mathbf{B}^T = \begin{pmatrix} -14.6976 & 29.3951 & 3.9382 & -18.6358 & -43.1788 & -9.21578 & -3.96169 & 30.0013 \\ -29.3951 & -7.8764 & 7.8764 & 29.3951 & 15.216 & -11.1389 & -15.216 & -41.571 \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$\mathbf{k}_k =$$

$$\begin{pmatrix} 9.78042 & -1.81564 & -2.62065 & -5.34412 & 1.69644 & 4.19145 & 4.57743 & 7.07244 \\ -1.81564 & 8.3861 & 0.4865 & -7.05695 & -12.5785 & -1.65859 & 0.0307255 & 10.9506 \\ -2.62065 & 0.4865 & 0.702202 & 1.43195 & -0.45456 & -1.1231 & -1.22652 & -1.89505 \\ -5.34412 & -7.05695 & 1.43195 & 10.9691 & 11.3366 & -1.40977 & -3.38164 & -16.128 \\ 1.69644 & -12.5785 & -0.45456 & 11.3366 & 18.979 & 2.06853 & -0.547538 & -17.458 \\ 4.19145 & -1.65859 & -1.1231 & -1.40977 & 2.06853 & 1.89259 & 1.86537 & 1.68943 \\ 4.57743 & 0.0307255 & -1.22652 & -3.38164 & -0.547538 & 1.86537 & 2.23864 & 4.65155 \\ 7.07244 & 10.9506 & -1.89505 & -16.128 & -17.458 & 1.68943 & 4.65155 & 23.799 \end{pmatrix}$$

$$\mathbf{k}_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_q^T = (625.821 \quad 167.688 \quad 44.9319 \quad 167.688 \quad -323.949 \quad -86.8018 \quad -86.8018 \quad -323.949)$$

$$\text{Gauss point} = \{s \rightarrow -0.57735, t \rightarrow 0.57735\} \quad \text{Weight} = 1.$$

$$\mathbf{N}^T = \{0.166667, 0.0446582, 0.166667, 0.622008, -0.086273, -0.086273, -0.321975, -0.321975\}$$

$$\frac{\partial \mathbf{N}^T}{\partial s} =$$

$$(-0.105662 \quad 0.105662 \quad 0.394338 \quad -0.394338 \quad -0.149429 \quad -0.204124 \quad -0.557678 \quad 0.204124)$$

$$\frac{\partial \mathbf{N}^T}{\partial t} =$$

$$(-0.394338 \quad -0.105662 \quad 0.105662 \quad 0.394338 \quad 0.204124 \quad 0.149429 \quad -0.204124 \quad 0.557678)$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 66.6667 & -7.8764 \\ 0. & 74.5431 \end{pmatrix} \quad \det \mathbf{J} = 0.000201226$$

$$\mathbf{B}^T = \begin{pmatrix} -3.9382 & 7.8764 & 25.4569 & -29.3951 & -11.5697 & -14.7852 & -35.5707 & 9.21578 \\ -29.3951 & -7.8764 & 7.8764 & 29.3951 & 15.216 & 11.1389 & -15.216 & 41.571 \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$\mathbf{k}_k = \begin{pmatrix} 7.96477 & 1.81564 & -3.00435 & -6.77607 & -3.63758 & -2.43767 & 5.31866 & -11.3939 \\ 1.81564 & 1.12352 & 1.25388 & -4.19305 & -1.91042 & -1.84897 & -1.45174 & -2.30764 \\ -3.00435 & 1.25388 & 6.43001 & -4.67955 & -1.58177 & -2.6138 & -9.28489 & 5.08933 \\ -6.77607 & -4.19305 & -4.67955 & 15.6487 & 7.12977 & 6.90044 & 5.41797 & 8.61224 \\ -3.63758 & -1.91042 & -1.58177 & 7.12977 & 3.30863 & 3.08375 & 1.63007 & 4.76231 \\ -2.43767 & -1.84897 & -2.6138 & 6.90044 & 3.08375 & 3.10301 & 3.22755 & 2.95921 \\ 5.31866 & -1.45174 & -9.28489 & 5.41797 & 1.63007 & 3.22755 & 13.5538 & -8.6962 \\ -11.3939 & -2.30764 & 5.08933 & 8.61224 & 4.76231 & 2.95921 & -8.6962 & 16.4177 \end{pmatrix}$$

$$\mathbf{k}_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_q^T = (167.688 \quad 44.9319 \quad 167.688 \quad 625.821 \quad -86.8018 \quad -86.8018 \quad -323.949 \quad -323.949)$$

$$\text{Gauss point} = \{s \rightarrow 0.57735, t \rightarrow -0.57735\} \quad \text{Weight} = 1.$$

$$\mathbf{N}^T = \{0.166667, 0.622008, 0.166667, 0.0446582, -0.321975, -0.321975, -0.086273, -0.086273\}$$

$$\partial \mathbf{N}^T / \partial s =$$

$$(-0.394338 \quad 0.394338 \quad 0.105662 \quad -0.105662 \quad 0.557678 \quad -0.204124 \quad 0.149429 \quad 0.204124)$$

$$\partial \mathbf{N}^T / \partial t =$$

$$(-0.105662 \quad -0.394338 \quad 0.394338 \quad 0.105662 \quad 0.204124 \quad -0.557678 \quad -0.204124 \quad -0.149429)$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 66.6667 & -43.4056 \\ 0. & 110.072 \end{pmatrix} \quad \det \mathbf{J} = 0.000136274$$

$$\mathbf{B}^T = \begin{pmatrix} -21.7028 & 43.4056 & -10.0723 & -11.6305 & 28.3184 & 10.5981 & 18.8221 & 20.0943 \\ -11.6305 & -43.4056 & 43.4056 & 11.6305 & 22.4684 & -61.3849 & -22.4684 & -16.448 \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$\mathbf{k}_k =$$

$$\begin{pmatrix} 3.71792 & -2.68103 & -1.75527 & 0.718379 & -5.37136 & 2.96761 & -0.902516 & -1.50123 \\ -2.68103 & 23.1072 & -14.2347 & -6.19157 & 1.55713 & 19.1603 & 10.9906 & 9.72677 \\ -1.75527 & -14.2347 & 12.1758 & 3.81416 & 4.23146 & -16.9939 & -7.14318 & -5.61926 \\ 0.718379 & -6.19157 & 3.81416 & 1.65903 & -0.417231 & -5.13398 & -2.94493 & -2.60628 \\ -5.37136 & 1.55713 & 4.23146 & -0.417231 & 8.01348 & -6.6174 & 0.172815 & 1.22327 \\ 2.96761 & 19.1603 & -16.9939 & -5.13398 & -6.6174 & 23.796 & 9.6811 & 7.49752 \\ -0.902516 & 10.9906 & -7.14318 & -2.94493 & 0.172815 & 9.6811 & 5.26829 & 4.58563 \\ -1.50123 & 9.72677 & -5.61926 & -2.60628 & 1.22327 & 7.49752 & 4.58563 & 4.13516 \end{pmatrix}$$

$$\mathbf{k}_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_q^T = (113.562 \quad 423.818 \quad 113.562 \quad 30.4288 \quad -219.384 \quad -219.384 \quad -58.7839 \quad -58.7839)$$

$$\text{Gauss point} = \{s \rightarrow 0.57735, t \rightarrow 0.57735\} \quad \text{Weight} = 1.$$

$$\mathbf{N}^T = \{0.0446582, 0.166667, 0.622008, 0.166667, -0.086273, -0.321975, -0.321975, -0.086273\}$$

$$\partial \mathbf{N}^T / \partial s =$$

$$(-0.105662 \quad 0.105662 \quad 0.394338 \quad -0.394338 \quad 0.149429 \quad -0.204124 \quad 0.557678 \quad 0.204124)$$

$$\partial \mathbf{N}^T / \partial t =$$

$$(-0.105662 \quad -0.394338 \quad 0.394338 \quad 0.105662 \quad 0.204124 \quad 0.557678 \quad -0.204124 \quad 0.149429)$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 66.6667 & -11.6305 \\ 0. & 110.072 \end{pmatrix} \quad \det \mathbf{J} = 0.000136274$$

$$\mathbf{B}^T = \begin{pmatrix} -5.81525 & 11.6305 & 21.7028 & -27.5181 & 7.58788 & -20.0943 & 39.5526 & 11.8703 \\ -11.6305 & -43.4056 & 43.4056 & 11.6305 & 22.4684 & 61.3849 & -22.4684 & 16.448 \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$k_k = \begin{pmatrix} 22.5 & 1.9984 \times 10^{-15} & -11.25 & -11.25 & -9.18559 \\ 6.66134 \times 10^{-16} & 45. & -22.5 & -22.5 & -18.3712 \\ -11.25 & -22.5 & 33.75 & 1.55431 \times 10^{-15} & 9.18559 \\ -11.25 & -22.5 & 1.9984 \times 10^{-15} & 33.75 & 18.3712 \\ -9.18559 & -18.3712 & 9.18559 & 18.3712 & 33.75 \\ 1.05988 & -2.11975 & -7.06584 & 8.12571 & 6.05769 \\ 9.18559 & 18.3712 & -18.3712 & -9.18559 & -6.66134 \times 10^{-16} \\ -7.41913 & 14.8383 & 3.53292 & -10.952 & -8.65385 \end{pmatrix}$$

$$\mathbf{r}_q^T = (937.5 \quad 750. \quad 750. \quad 937.5 \quad -688.919 \quad -612.372 \quad -688.919 \quad -765.466)$$

Natural boundary conditions

Specified NBC values for side 2: $\alpha = -55$ $\beta = 1100$

Interpolation functions for mapping: $\left\{0, \frac{1-a}{2}, \frac{a+1}{2}, 0\right\}$

Interpolation functions for solution: $\left\{0, \frac{1-a}{2}, \frac{a+1}{2}, 0, 0, \frac{\frac{3a^2}{2} - \frac{3}{2}}{\sqrt{6}}, 0, 0\right\}$

$x(a) = 0.03$ $y(a) = 0.0075 a + 0.0225$

$J_c = 0.0075$

Value in mapped coordinate: $\alpha(a) = -55$ $\beta(a) = 1100$

Gauss point = -0.57735 Weight = 1.

$\mathbf{N}_c^T = \{0., 0.788675, 0.211325, 0., 0., -0.408248, 0., 0.\}$

$J_c = 0.0075$ $\alpha = -55.$ $\beta = 1100.$

$$\mathbf{k}_\alpha = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & -0.256578 & -0.06875 & 0. & 0. & 0.132815 & 0. & 0. \\ 0. & -0.06875 & -0.0184215 & 0. & 0. & 0.0355876 & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0.132815 & 0.0355876 & 0. & 0. & -0.06875 & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix} \quad \mathbf{r}_\beta = \begin{pmatrix} 0. \\ -6.50657 \\ -1.74343 \\ 0. \\ 0. \\ 3.36805 \\ 0. \\ 0. \end{pmatrix}$$

Gauss point = 0.57735 Weight = 1.

$\mathbf{N}_c^T = \{0., 0.211325, 0.788675, 0., 0., -0.408248, 0., 0.\}$

$J_c = 0.0075$ $\alpha = -55.$ $\beta = 1100.$

$$\mathbf{k}_\alpha = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & -0.0184215 & -0.06875 & 0. & 0. & 0.0355876 & 0. & 0. \\ 0. & -0.06875 & -0.256578 & 0. & 0. & 0.132815 & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0.0355876 & 0.132815 & 0. & 0. & -0.06875 & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix} \quad \mathbf{r}_\beta = \begin{pmatrix} 0. \\ -1.74343 \\ -6.50657 \\ 0. \\ 0. \\ 3.36805 \\ 0. \\ 0. \end{pmatrix}$$

Adding contributions from all Gauss points

$$\mathbf{k}_\alpha = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & -0.275 & -0.1375 & 0. & 0. & 0.168402 & 0. \\ 0. & -0.1375 & -0.275 & 0. & 0. & 0.168402 & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0.168402 & 0.168402 & 0. & 0. & -0.1375 & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix} \quad \mathbf{r}_\beta = \begin{pmatrix} 0. \\ -8.25 \\ -8.25 \\ 0. \\ 0. \\ 6.7361 \\ 0. \\ 0. \end{pmatrix}$$

Specified NBC values for side 3: $\alpha = -55$ $\beta = 1100$

Interpolation functions for mapping: $\left\{0, 0, \frac{1-a}{2}, \frac{a+1}{2}\right\}$

Interpolation functions for solution: $\left\{0, 0, \frac{1-a}{2}, \frac{a+1}{2}, 0, 0, \frac{\frac{3a^2}{2} - \frac{3}{2}}{\sqrt{6}}, 0\right\}$

$x(a) = 0.015 - 0.015 a$ $y(a) = 0.03$

$J_c = 0.015$

Value in mapped coordinate: $\alpha(a) = -55$ $\beta(a) = 1100$

Gauss point = -0.57735 Weight = 1.

$\mathbf{N}_c^T = \{0., 0., 0.788675, 0.211325, 0., 0., -0.408248, 0.\}$

$J_c = 0.015$ $\alpha = -55.$ $\beta = 1100.$

$$\mathbf{k}_\alpha = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & -0.513157 & -0.1375 & 0. & 0. & 0.26563 & 0. \\ 0. & 0. & -0.1375 & -0.036843 & 0. & 0. & 0.0711752 & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0.26563 & 0.0711752 & 0. & 0. & -0.1375 & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix} \quad \mathbf{r}_\beta = \begin{pmatrix} 0. \\ 0. \\ -13.0131 \\ -3.48686 \\ 0. \\ 0. \\ 6.7361 \\ 0. \end{pmatrix}$$

Gauss point = 0.57735 Weight = 1.

$\mathbf{N}_c^T = \{0., 0., 0.211325, 0.788675, 0., 0., -0.408248, 0.\}$

$J_c = 0.015$ $\alpha = -55.$ $\beta = 1100.$

$$\mathbf{k}_\alpha = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & -0.036843 & -0.1375 & 0. & 0. & 0.0711752 & 0. \\ 0. & 0. & -0.1375 & -0.513157 & 0. & 0. & 0.26563 & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0.0711752 & 0.26563 & 0. & 0. & -0.1375 & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix} \quad \mathbf{r}_\beta = \begin{pmatrix} 0. \\ 0. \\ -3.48686 \\ -13.0131 \\ 0. \\ 0. \\ 6.7361 \\ 0. \end{pmatrix}$$

Adding contributions from all Gauss points

$$\mathbf{k}_\alpha = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & -0.55 & -0.275 & 0. & 0. & 0.336805 & 0. \\ 0. & 0. & -0.275 & -0.55 & 0. & 0. & 0.336805 & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0.336805 & 0.336805 & 0. & 0. & -0.275 & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix} \quad \mathbf{r}_\beta = \begin{pmatrix} 0. \\ 0. \\ -16.5 \\ -16.5 \\ 0. \\ 0. \\ 13.4722 \\ 0. \end{pmatrix}$$

Specified NBC values for side 4: $\alpha = 0$ $\beta = 8000$

Interpolation functions for mapping: $\left\{ \frac{a+1}{2}, 0, 0, \frac{1-a}{2} \right\}$

Interpolation functions for solution: $\left\{ \frac{a+1}{2}, 0, 0, \frac{1-a}{2}, 0, 0, 0, \frac{\frac{3a^2}{2} - \frac{3}{2}}{\sqrt{6}} \right\}$

$x(a) = 0$ $y(a) = 0.015 - 0.015 a$

$J_c = 0.015$

Value in mapped coordinate: $\alpha(a) = 0$ $\beta(a) = 8000$

Gauss point = -0.57735 Weight = 1.

$\mathbf{N}_c^T = \{0.211325, 0., 0., 0.788675, 0., 0., 0., -0.408248\}$

$J_c = 0.015$ $\alpha = 0.$ $\beta = 8000.$

$$\mathbf{k}_\alpha = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix} \quad \mathbf{r}_\beta = \begin{pmatrix} -25.359 \\ 0. \\ 0. \\ -94.641 \\ 0. \\ 0. \\ 0. \\ 48.9898 \end{pmatrix}$$

Gauss point = 0.57735 Weight = 1.

$$\mathbf{N}_c^T = \{0.788675, 0., 0., 0.211325, 0., 0., 0., -0.408248\}$$

$$J_c = 0.015 \quad \alpha = 0. \quad \beta = 8000.$$

$$\mathbf{k}_\alpha = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix} \quad \mathbf{r}_\beta = \begin{pmatrix} -94.641 \\ 0. \\ 0. \\ -25.359 \\ 0. \\ 0. \\ 0. \\ 48.9898 \end{pmatrix}$$

Adding contributions from all Gauss points

$$\mathbf{k}_\alpha = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix} \quad \mathbf{r}_\beta = \begin{pmatrix} -120. \\ 0. \\ 0. \\ -120. \\ 0. \\ 0. \\ 0. \\ 97.9796 \end{pmatrix}$$

$$\begin{pmatrix} 22.5 & 0 & -11.25 & -11.25 & -9.18559 & 1.05988 & 9.18559 & -7.41913 \\ 0 & 44.725 & -22.6375 & -22.5 & -18.3712 & -1.95135 & 18.3712 & 14.8383 \\ -11.25 & -22.6375 & 32.925 & -0.275 & 9.18559 & -6.89743 & -18.0344 & 3.53292 \\ -11.25 & -22.5 & -0.275 & 33.2 & 18.3712 & 8.12571 & -8.84878 & -10.952 \\ -9.18559 & -18.3712 & 9.18559 & 18.3712 & 33.75 & 6.05769 & 0 & -8.65385 \\ 1.05988 & -1.95135 & -6.89743 & 8.12571 & 6.05769 & 54.2375 & 1.44231 & 16.875 \\ 9.18559 & 18.3712 & -18.0344 & -8.84878 & 0 & 1.44231 & 33.475 & 1.15385 \\ -7.41913 & 14.8383 & 3.53292 & -10.952 & -8.65385 & 16.875 & 1.15385 & 46.875 \end{pmatrix}$$

$$\begin{pmatrix} T_1 \\ T_4 \\ T_5 \\ T_6 \\ \delta_1^{(1,4)} \\ \delta_1^{(4,5)} \\ \delta_1^{(5,6)} \\ \delta_1^{(1,6)} \end{pmatrix} = \begin{pmatrix} 817.5 \\ 741.75 \\ 725.25 \\ 801. \\ -688.919 \\ -605.636 \\ -675.447 \\ -667.486 \end{pmatrix}$$

Global equations after assembling all elements

$$\begin{pmatrix} 47.5962 & 19.9038 & -6.05769 & -38.9423 & -11.25 & -11.25 & -29.6765 & -3.53292 & -7.41913 \\ 19.9038 & 70.0962 & -38.9423 & -51.0577 & 0 & 0 & -43.8082 & 31.0897 & 0 \\ -6.05769 & -38.9423 & 43.5846 & 0.590385 & 0 & 0 & 14.1317 & -16.2514 & 0 \\ -38.9423 & -51.0577 & 0.590385 & 133.31 & -22.6375 & -22.5 & 59.353 & -38.8621 & 14.8383 \\ -11.25 & 0 & 0 & -22.6375 & 32.925 & -0.275 & 0 & 9.18559 & 3.53292 \\ -11.25 & 0 & 0 & -22.5 & -0.275 & 33.2 & 0 & 18.3712 & -10.952 \\ -29.6765 & -43.8082 & 14.1317 & 59.353 & 0 & 0 & 57.6923 & -34.6154 & 0 \\ -3.53292 & 31.0897 & -16.2514 & -38.8621 & 9.18559 & 18.3712 & -34.6154 & 129.808 & -8.65385 \\ -7.41913 & 0 & 0 & 14.8383 & 3.53292 & -10.952 & 0 & -8.65385 & 46.875 \\ -5.65267 & 5.65267 & -20.4909 & 20.4909 & 0 & 0 & 4.61538 & 38.9423 & 0 \\ 4.2395 & 32.5028 & -27.9265 & -8.1422 & 0 & 0 & -10.3846 & 24.2308 & 0 \\ 1.05988 & 0 & 0 & -1.95135 & -6.89743 & 8.12571 & 0 & 6.05769 & 16.875 \\ 9.18559 & 0 & 0 & 18.3712 & -18.0344 & -8.84878 & 0 & 0 & 1.15385 \end{pmatrix}$$

Essential boundary conditions

On element 1, side 1, specified value = 110

$$\{T_1, T_2, \delta_1^{[1,2]}\} = \{110, 110, 0\}$$

Known values from EBC

$$\{T_1 = 110, T_2 = 110, \delta_1^{[1,2]} = 0\}$$

Global equations after EBC

$$\begin{pmatrix} 43.5846 & 0.590385 & 0 & 0 & -16.2514 & 0 & -20.4909 & -27.9265 & 0 \\ 0.590385 & 133.31 & -22.6375 & -22.5 & -38.8621 & 14.8383 & 20.4909 & -8.1422 & -1.95135 \\ 0 & -22.6375 & 32.925 & -0.275 & 9.18559 & 3.53292 & 0 & 0 & -6.89743 \\ 0 & -22.5 & -0.275 & 33.2 & 18.3712 & -10.952 & 0 & 0 & 8.12571 \\ -16.2514 & -38.8621 & 9.18559 & 18.3712 & 129.808 & -8.65385 & 38.9423 & 24.2308 & 6.05769 \\ 0 & 14.8383 & 3.53292 & -10.952 & -8.65385 & 46.875 & 0 & 0 & 16.875 \\ -20.4909 & 20.4909 & 0 & 0 & 38.9423 & 0 & 96.0577 & 5.76923 & 0 \\ -27.9265 & -8.1422 & 0 & 0 & 24.2308 & 0 & 5.76923 & 35.4942 & 0 \\ 0 & -1.95135 & -6.89743 & 8.12571 & 6.05769 & 16.875 & 0 & 0 & 54.2371 \\ 0 & 18.3712 & -18.0344 & -8.84878 & 0 & 1.15385 & 0 & 0 & 1.4421 \end{pmatrix}$$

Solving the final system of global equations we get

$$\{T_3 = 129.195, T_4 = 138.48, T_5 = 162.431, T_6 = 160.634, \delta_1^{[1,4]} = -12.0338, \\ \delta_1^{[1,6]} = -15.6763, \delta_1^{[2,3]} = -4.97674, \delta_1^{[3,4]} = 11.6987, \delta_1^{[4,5]} = -5.63838, \delta_1^{[5,6]} = 4.39332\}$$

Solution for element 1

DOF values for the element

$$\{T_1 = 110, T_2 = 110, T_3 = 129.195, T_4 = 138.48, \delta_1^{[1,2]} = 0, \delta_1^{[2,3]} = -4.97674, \delta_1^{[3,4]} = 11.6987, \delta_1^{[1,4]} = -12.0338\}$$

$$\mathbf{d}^T = (110 \ 110 \ 129.195 \ 138.48 \ 0 \ -4.97674 \ 11.6987 \ -12.0338)$$

Mapping

$$x(s,t) = -0.0075ts + 0.0225s + 0.0075t + 0.0375$$

$$y(s,t) = 0.0075t + 0.0075$$

$$\mathbf{J} = \begin{pmatrix} 0.0225 - 0.0075t & 0.0075 - 0.0075s \\ 0 & 0.0075 \end{pmatrix}$$

Element solution at $\{s \rightarrow 0, t \rightarrow 0\}$

Location: $\{0.0375, 0.0075\}$

$$\mathbf{N}^T = (0.25 \ 0.25 \ 0.25 \ 0.25 \ -0.306186 \ -0.306186 \ -0.306186 \ -0.306186)$$

$$\partial \mathbf{N}^T / \partial s = (-0.25 \quad 0.25 \quad 0.25 \quad -0.25 \quad 0. \quad -0.306186 \quad 0. \quad 0.306186)$$

$$\partial \mathbf{N}^T / \partial t = (-0.25 \quad -0.25 \quad 0.25 \quad 0.25 \quad 0.306186 \quad 0. \quad -0.306186 \quad 0.)$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 44.4444 & 0. \\ -44.4444 & 133.333 \end{pmatrix}$$

$$\mathbf{B}_x^T = \partial \mathbf{N}^T / \partial x = (-11.1111 \quad 11.1111 \quad 11.1111 \quad -11.1111 \quad 0. \quad -13.6083 \quad 0. \quad 13.6083)$$

$$\mathbf{B}_y^T = \partial \mathbf{N}^T / \partial y = (-22.2222 \quad -44.4444 \quad 22.2222 \quad 44.4444 \quad 40.8248 \quad 13.6083 \quad -40.8248 \quad -13.6083)$$

$$T = \mathbf{N}^T \mathbf{d} = 123.545$$

$$\partial T / \partial x = \mathbf{B}_x^T \mathbf{d} = -199.205$$

$$\partial T / \partial y = \mathbf{B}_y^T \mathbf{d} = 1310.77$$

	x	y	T	$\partial T / \partial x$	$\partial T / \partial y$
1	0.0375	0.0075	123.545	-199.205	1310.77

Solution for element 2

DOF values for the element

$$\{T_1 = 110, T_4 = 138.48, T_5 = 162.431, T_6 = 160.634, \\ \delta_1^{[1,4]} = -12.0338, \delta_1^{[4,5]} = -5.63838, \delta_1^{[5,6]} = 4.39332, \delta_1^{[1,6]} = -15.6763\}$$

$$\mathbf{d}^T = (110 \quad 138.48 \quad 162.431 \quad 160.634 \quad -12.0338 \quad -5.63838 \quad 4.39332 \quad -15.6763)$$

Mapping

$$x(s,t) = 0.015s + 0.015$$

$$y(s,t) = -0.00375ts + 0.00375s + 0.01125t + 0.01875$$

$$\mathbf{J} = \begin{pmatrix} 0.015 & 0 \\ 0.00375 - 0.00375t & 0.01125 - 0.00375s \end{pmatrix}$$

Element solution at $\{s \rightarrow 0, t \rightarrow 0\}$

Location: $\{0.015, 0.01875\}$

$$\mathbf{N}^T = (0.25 \quad 0.25 \quad 0.25 \quad 0.25 \quad -0.306186 \quad -0.306186 \quad -0.306186 \quad -0.306186)$$

$$\partial \mathbf{N}^T / \partial s = (-0.25 \quad 0.25 \quad 0.25 \quad -0.25 \quad 0. \quad -0.306186 \quad 0. \quad 0.306186)$$

$$\partial \mathbf{N}^T / \partial t = (-0.25 \quad -0.25 \quad 0.25 \quad 0.25 \quad 0.306186 \quad 0. \quad -0.306186 \quad 0.)$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 66.6667 & -22.2222 \\ 0. & 88.8889 \end{pmatrix}$$

$$\mathbf{B}_x^T = \partial \mathbf{N}^T / \partial x = (-11.1111 \quad 22.2222 \quad 11.1111 \quad -22.2222 \quad -6.80414 \quad -20.4124 \quad 6.80414 \quad 20.4124)$$

$$\mathbf{B}_y^T = \partial \mathbf{N}^T / \partial y = (-22.2222 \quad -22.2222 \quad 22.2222 \quad 22.2222 \quad 27.2166 \quad 0. \quad -27.2166 \quad 0.)$$

$$\mathbf{T} = \mathbf{N}^T \mathbf{d} = 151.752$$

$$\partial \mathbf{T} / \partial x = \mathbf{B}_x^T \mathbf{d} = -2.87239$$

$$\partial \mathbf{T} / \partial y = \mathbf{B}_y^T \mathbf{d} = 1210.35$$

	x	y	\mathbf{T}	$\partial \mathbf{T} / \partial x$	$\partial \mathbf{T} / \partial y$
1	0.015	0.01875	151.752	-2.87239	1210.35

Nodal solution summary

dof	x	y	Value
\mathbf{T}_1	0	0	110
\mathbf{T}_2	0.06	0	110
\mathbf{T}_3	0.06	0.015	129.195
\mathbf{T}_4	0.03	0.015	138.48
\mathbf{T}_5	0.03	0.03	162.431
\mathbf{T}_6	0	0.03	160.634

Element solution summary

	x	y	\mathbf{T}	$\partial \mathbf{T} / \partial x$	$\partial \mathbf{T} / \partial y$
1	0.0375	0.0075	123.545	-199.205	1310.77
2	0.015	0.01875	151.752	-2.87239	1210.35

With $n = 3$ the following finite element solution is obtained.

Interpolation functions for mapping: $\left\{ \frac{1}{4} (1-s)(1-t), \frac{1}{4} (s+1)(1-t), \frac{1}{4} (s+1)(t+1), \frac{1}{4} (1-s)(t+1) \right\}$

Interpolation functions for assumed solution: $\mathbf{N}^T = \left\{ \frac{1}{4} (1-s)(1-t), \frac{1}{4} (s+1)(1-t), \frac{1}{4} (s+1)(t+1), \right.$

$$\frac{1}{4} (1-s)(t+1), \frac{\left(\frac{3s^2}{2} - \frac{3}{2}\right)(1-t)}{2\sqrt{6}}, \frac{(s+1)\left(\frac{3t^2}{2} - \frac{3}{2}\right)}{2\sqrt{6}}, \frac{\left(\frac{3s^2}{2} - \frac{3}{2}\right)(t+1)}{2\sqrt{6}}, \frac{(1-s)\left(\frac{3t^2}{2} - \frac{3}{2}\right)}{2\sqrt{6}},$$

$$\left. \frac{\left(\frac{5s^3}{2} - \frac{5s}{2}\right)(1-t)}{2\sqrt{10}}, \frac{(s+1)\left(\frac{5t^3}{2} - \frac{5t}{2}\right)}{2\sqrt{10}}, \frac{\left(\frac{5s^3}{2} - \frac{5s}{2}\right)(t+1)}{2\sqrt{10}}, \frac{(1-s)\left(\frac{5t^3}{2} - \frac{5t}{2}\right)}{2\sqrt{10}} \right\}$$

$$\partial \mathbf{N}^T / \partial s = \left\{ \frac{t-1}{4}, \frac{1-t}{4}, \frac{t+1}{4}, \frac{1}{4} (-t-1), \frac{1}{2} \sqrt{\frac{3}{2}} s(1-t), \frac{\frac{3t^2}{2} - \frac{3}{2}}{2\sqrt{6}}, \frac{1}{2} \sqrt{\frac{3}{2}} s(t+1), \right.$$

$$\left. -\frac{\frac{3t^2}{2} - \frac{3}{2}}{2\sqrt{6}}, \frac{\left(\frac{15s^2}{2} - \frac{5}{2}\right)(1-t)}{2\sqrt{10}}, \frac{\frac{5t^3}{2} - \frac{5t}{2}}{2\sqrt{10}}, \frac{\left(\frac{15s^2}{2} - \frac{5}{2}\right)(t+1)}{2\sqrt{10}}, -\frac{\frac{5t^3}{2} - \frac{5t}{2}}{2\sqrt{10}} \right\}$$

$$\partial \mathbf{N}^T / \partial t = \left\{ \frac{s-1}{4}, \frac{1}{4} (-s-1), \frac{s+1}{4}, \frac{1-s}{4}, -\frac{\frac{3s^2}{2} - \frac{3}{2}}{2\sqrt{6}}, \frac{1}{2} \sqrt{\frac{3}{2}} (s+1)t, \frac{\frac{3s^2}{2} - \frac{3}{2}}{2\sqrt{6}}, \right.$$

$$\left. \frac{1}{2} \sqrt{\frac{3}{2}} (1-s)t, -\frac{\frac{5s^3}{2} - \frac{5s}{2}}{2\sqrt{10}}, \frac{(s+1)\left(\frac{15t^2}{2} - \frac{5}{2}\right)}{2\sqrt{10}}, \frac{\frac{5s^3}{2} - \frac{5s}{2}}{2\sqrt{10}}, \frac{(1-s)\left(\frac{15t^2}{2} - \frac{5}{2}\right)}{2\sqrt{10}} \right\}$$

Use 3×3 Gauss quadrature for integration.

Global equations at start of the element assembly process

Equations for element 1

$$x(s,t) = -0.0075ts + 0.0225s + 0.0075t + 0.0375$$

$$J = \begin{pmatrix} 0.0225 - 0.0075t & 0.0075 - 0.0075s \\ 0 & 0.0075 \end{pmatrix}$$

Given element data

Element data in mapped coordinates

$$k_x = 45 \quad k_y = 45 \quad p = 0 \quad q = 5000000$$

Gauss point = {s → -0.774597, t → -0.774597} Weight = 0.308642

$$\mathbf{N}^T = \{0.787298, 0.1, 0.0127017, 0.1, -0.217343, -0.0276062, -0.0276062, -0.217343, 0.217343, 0.0276062, 0.0276062, 0.217343\}$$

$$\partial \mathbf{N}^T / \partial s = (-0.443649 \quad 0.443649 \quad 0.0563508 \quad -0.0563508 \quad -0.841765 \quad -0.122474 \quad -0.106918 \quad 0.122474 \quad 0.106918 \quad -0.122474 \quad -0.0563508 \quad 0.0563508)$$

$$\partial \mathbf{N}^T / \partial t = (-0.443649 \quad -0.0563508 \quad 0.0563508 \quad 0.443649 \quad 0.122474 \quad -0.106918 \quad -0.122474 \quad -0.841765 \quad -0.106918 \quad 0.122474 \quad -0.0563508 \quad 0.0563508)$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 35.3239 & 0. \\ -62.6856 & 133.333 \end{pmatrix} \quad \det \mathbf{J} = 0.000212321$$

$$\mathbf{B}^T = \begin{pmatrix} -15.6714 & 15.6714 & 1.99053 & -1.99053 & -29.7344 & -4.32627 & -3.77676 & 4.32627 & 19.9053 \\ -31.3428 & -35.3239 & 3.98106 & 62.6856 & 69.0965 & -6.57837 & -9.6277 & -119.913 & -51.3428 \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$\mathbf{k}_k = \begin{pmatrix} 3.62115 & 2.54065 & -0.459946 & -5.70185 & -5.01225 & 0.80795 & 1.0644 \\ 2.54065 & 4.4038 & -0.322704 & -6.62174 & -8.57168 & 0.485315 & 0.828348 \\ -0.459946 & -0.322704 & 0.0584208 & 0.72423 & 0.636639 & -0.102623 & -0.135196 \\ -5.70185 & -6.62174 & 0.72423 & 11.5994 & 12.9473 & -1.19064 & -1.75755 \\ -5.01225 & -8.57168 & 0.636639 & 12.9473 & 16.6863 & -0.961057 & -1.63057 \\ 0.80795 & 0.485315 & -0.102623 & -1.19064 & -0.961057 & 0.182807 & 0.234951 \\ 1.0644 & 0.828348 & -0.135196 & -1.75755 & -1.63057 & 0.234951 & 0.315405 \\ 10.8832 & 12.6908 & -1.38235 & -22.1917 & -24.8126 & 2.27099 & 3.35628 \\ 3.84461 & 6.28146 & -0.488329 & -9.63774 & -12.2333 & 0.7463 & 1.24159 \\ -0.368745 & 0.00967665 & 0.0468368 & 0.312232 & -0.00718859 & -0.0906248 & -0.100038 \\ -1.21271 & -1.11924 & 0.154034 & 2.17792 & 2.19617 & -0.262228 & -0.364812 \\ -7.42538 & -8.79378 & 0.943146 & 15.276 & 17.1896 & -1.54524 & -2.29411 \end{pmatrix}$$

$$\mathbf{k}_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_q^T = (257.963 \quad 32.7656 \quad 4.16178 \quad 32.7656 \quad -71.2137 \quad -9.04532 \quad -9.04532 \quad -71.2137 \quad 71.2137 \quad 9.04532)$$

Gauss point = $\{s \rightarrow -0.774597, t \rightarrow 0.\}$ Weight = 0.493827

$$\mathbf{N}^T = \{0.443649, 0.0563508, 0.0563508, 0.443649, \\ -0.122474, -0.0690154, -0.122474, -0.543357, 0.122474, 0., 0.122474, 0.\}$$

$$\partial \mathbf{N}^T / \partial \mathbf{s} =$$

$$\begin{pmatrix} -0.25 & 0.25 & 0.25 & -0.25 & -0.474342 & -0.306186 & -0.474342 & 0.306186 & 0.316228 & 0. & 0.316228 & 0. \end{pmatrix}$$

$$\partial \mathbf{N}^T / \partial t = (-0.443649 \quad -0.0563508 \quad 0.0563508 \quad 0.443649 \quad 0.122474 \quad 0. \quad -0.122474 \quad 0. \quad -0.122474$$

$$J^{-T} = \begin{pmatrix} 44.4444 & 0. \\ -78.871 & 133.333 \end{pmatrix} \quad \det J = 0.00016875$$

$$\mathbf{B}^T = \begin{pmatrix} -11.1111 & 11.1111 & 11.1111 & -11.1111 & -21.0819 & -13.6083 & -21.0819 & 13.6083 & 14.1111 \\ -39.4355 & -27.2312 & -12.2043 & 78.871 & 53.7417 & 24.1492 & 21.0819 & -24.1492 & -41.1111 \end{pmatrix}$$

$k_x = 45.$	$k_y = 45.$	$p = 0.$	$q = 5. \times 10^6$					
$k_k =$	6.2948	3.56407	1.34185	-11.2007	-7.06908	-3.00425	-2.23924	3.00425
	3.56407	3.24373	1.70923	-8.51702	-6.36635	-3.03305	-3.03122	3.03305
	1.34185	1.70923	1.02151	-4.07258	-3.33796	-1.67223	-1.84324	1.67223
	-11.2007	-8.51702	-4.07258	23.7903	16.7734	7.70953	7.11371	-7.70953
	-7.06908	-6.36635	-3.33796	16.7734	12.4973	5.94265	5.91532	-5.94265
	-3.00425	-3.03305	-1.67223	7.70953	5.94265	2.88138	2.98499	-2.88138
	-2.23924	-3.03122	-1.84324	7.11371	5.91532	2.98499	3.33333	-2.98499
	3.00425	3.03305	1.67223	-7.70953	-5.94265	-2.88138	-2.98499	2.88138
	5.51769	4.80009	2.47443	-12.7922	-9.42854	-4.45471	-4.37388	4.45471
	1.75682	1.21313	0.543692	-3.51364	-2.39415	-1.07583	-0.939181	1.07583
	0.687852	1.46496	0.979711	-3.13252	-2.84655	-1.49705	-1.79189	1.49705
	13.8314	9.55094	4.28048	-27.6628	-18.8491	-8.46998	-7.39415	8.46998

[illegible]

Gauss point = {s \rightarrow -0.774597, t \rightarrow 0.774597} Weight = 0.308642

$$\partial \mathbf{N}^T / \partial \mathbf{s} = \begin{pmatrix} -0.0563508 & 0.0563508 & 0.443649 & -0.443649 & -0.106918 & -0.122474 & -0.841765 & 0.122474 \end{pmatrix}$$

$$\partial \mathbf{N}^T / \partial t = (-0.443649 \quad -0.0563508 \quad 0.0563508 \quad 0.443649 \quad 0.122474 \quad 0.106918 \quad -0.122474 \quad 0.841765)$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 59.9142 & 0. \\ -106.324 & 133.333 \end{pmatrix} \quad \det \mathbf{J} = 0.000125179$$

$$\mathbf{B}^T = \begin{pmatrix} -3.37622 & 3.37622 & 26.5809 & -26.5809 & -6.40592 & -7.33796 & -50.4337 & 7.33796 \\ -53.1618 & -13.5049 & -39.6569 & 106.324 & 27.6979 & 27.2777 & 73.1696 & 99.2134 & -2 \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$\mathbf{k}_k = \begin{pmatrix} 4.9334 & 1.2284 & 3.50934 & -9.67113 & -2.52243 & -2.47812 & -6.4668 & -9.21306 & 2 \\ 1.2284 & 0.336906 & 1.08715 & -2.65245 & -0.687934 & -0.68354 & -2.01403 & -2.28641 & 0 \\ 3.50934 & 1.08715 & 3.96264 & -8.55913 & -2.20573 & -2.21984 & -7.37557 & -6.50139 & 1 \\ -9.67113 & -2.65245 & -8.55913 & 20.8827 & 5.41609 & 5.3815 & 15.8564 & 18.0009 & -4 \\ -2.52243 & -0.687934 & -2.20573 & 5.41609 & 1.40515 & 1.39529 & 4.08521 & 4.69594 & -1 \\ -2.47812 & -0.68354 & -2.21984 & 5.3815 & 1.39529 & 1.38726 & 4.11348 & 4.61157 & -1 \\ -6.4668 & -2.01403 & -7.37557 & 15.8564 & 4.08521 & 4.11348 & 13.7303 & 11.9777 & -3 \\ -9.21306 & -2.28641 & -6.50139 & 18.0009 & 4.69594 & 4.61157 & 11.9777 & 17.2071 & -4 \\ 2.18473 & 0.586429 & 1.84579 & -4.61695 & -1.19889 & -1.18834 & -3.41593 & -4.06955 & 1 \\ -2.03891 & -0.571967 & -1.89221 & 4.50309 & 1.16646 & 1.1619 & 3.50898 & 3.7919 & -0 \\ 3.80809 & 1.21488 & 4.54174 & -9.56471 & -2.46135 & -2.48417 & -8.46107 & -7.04624 & 2 \\ -5.75521 & -1.408 & -3.92195 & 11.0852 & 2.89436 & 2.83732 & 7.21851 & 10.7539 & -2 \end{pmatrix}$$

[illegible]

$$\mathbf{r}_q^T = (19.3177 \quad 2.45367 \quad 19.3177 \quad 152.088 \quad -5.33288 \quad -5.33288 \quad -41.9857 \quad -41.9857 \quad 5.33288 \quad -5.33288)$$

$$\text{Gauss point} = \{s \rightarrow 0., t \rightarrow -0.774597\} \quad \text{Weight} = 0.493827$$

$$\mathbf{N}^T = \{0.443649, 0.443649, 0.0563508, 0.0563508, \\ -0.543357, -0.122474, -0.0690154, -0.122474, 0., 0.122474, 0., 0.122474\}$$

$$\partial \mathbf{N}^T / \partial s = (-0.443649 \quad 0.443649 \quad 0.0563508 \quad -0.0563508 \quad 0. \quad -0.122474 \quad 0. \quad 0.122474 \quad -0.701471$$

$$\partial \mathbf{N}^T / \partial t = \\ (-0.25 \quad -0.25 \quad 0.25 \quad 0.25 \quad 0.306186 \quad -0.474342 \quad -0.306186 \quad -0.474342 \quad 0. \quad 0.316228 \quad 0. \quad 0.316228)$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 35.3239 & 0. \\ -35.3239 & 133.333 \end{pmatrix} \quad \det \mathbf{J} = 0.000212321$$

$$\mathbf{B}^T = \begin{pmatrix} -15.6714 & 15.6714 & 1.99053 & -1.99053 & 0. & -4.32627 & 0. & 4.32627 & -24. \\ -17.6619 & -49.0047 & 31.3428 & 35.3239 & 40.8248 & -58.9193 & -40.8248 & -67.5718 & 24. \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$\mathbf{k}_k = \begin{pmatrix} 2.6306 & 2.92496 & -2.75908 & -2.79647 & -3.40207 & 5.22983 & 3.40207 & \\ 2.92496 & 12.4895 & -7.09979 & -8.31464 & -9.43937 & 13.3032 & 9.43937 & 1 \\ -2.75908 & -7.09979 & 4.65376 & 5.20511 & 6.0373 & -8.75379 & -6.0373 & - \\ -2.79647 & -8.31464 & 5.20511 & 5.90601 & 6.80414 & -9.77925 & -6.80414 & -1 \\ -3.40207 & -9.43937 & 6.0373 & 6.80414 & 7.86374 & -11.3491 & -7.86374 & -1 \\ 5.22983 & 13.3032 & -8.75379 & -9.77925 & -11.3491 & 16.4676 & 11.3491 & 1 \\ 3.40207 & 9.43937 & -6.0373 & -6.80414 & -7.86374 & 11.3491 & 7.86374 & 1 \\ 5.31109 & 15.9436 & -9.9521 & -11.3026 & -13.0158 & 18.6964 & 13.0158 & 2 \\ -0.232716 & -7.56141 & 3.43163 & 4.36249 & 4.77291 & -6.38257 & -4.77291 & - \\ -3.47301 & -8.42874 & 5.63615 & 6.26561 & 7.28831 & -10.607 & -7.28831 & -1 \\ -0.0295589 & -0.960424 & 0.435874 & 0.554109 & 0.606238 & -0.810692 & -0.606238 & - \\ -3.55427 & -11.0691 & 6.83445 & 7.78896 & 8.95497 & -12.8357 & -8.95497 & -1 \end{pmatrix}$$

$$\mathbf{k}_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_q^T = (232.583 \quad 232.583 \quad 29.5419 \quad 29.5419 \quad -284.855 \quad -64.2072 \quad -36.1813 \quad -64.2072 \quad 0. \quad 64.2072$$

$$\text{Gauss point} = \{s \rightarrow 0., t \rightarrow 0.\} \quad \text{Weight} = 0.790123$$

$$\mathbf{N}^T = \{0.25, 0.25, 0.25, 0.25, -0.306186, -0.306186, -0.306186, -0.306186, 0., 0., 0., 0.\}$$

$$\partial \mathbf{N}^T / \partial s =$$

$$(-0.25 \quad 0.25 \quad 0.25 \quad -0.25 \quad 0. \quad -0.306186 \quad 0. \quad 0.306186 \quad -0.395285 \quad 0. \quad -0.395285 \quad 0.)$$

$$\partial \mathbf{N}^T / \partial t = (-0.25 \quad -0.25 \quad 0.25 \quad 0.25 \quad 0.306186 \quad 0. \quad -0.306186 \quad 0. \quad 0. \quad -0.395285 \quad 0. \quad -0.395285)$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 44.4444 & 0. \\ -44.4444 & 133.333 \end{pmatrix} \quad \det \mathbf{J} = 0.00016875$$

$$\mathbf{B}^T = \begin{pmatrix} -11.1111 & 11.1111 & 11.1111 & -11.1111 & 0. & -13.6083 & 0. & 13.6083 & -17.568 \\ -22.2222 & -44.4444 & 22.2222 & 44.4444 & 40.8248 & 13.6083 & -40.8248 & -13.6083 & 17.568 \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$\mathbf{k}_k = \begin{pmatrix} 3.7037 & 5.18519 & -3.7037 & -5.18519 & -5.44331 & -0.907218 & 5.44331 & 0.907218 \\ 5.18519 & 12.5926 & -5.18519 & -12.5926 & -10.8866 & -4.53609 & 10.8866 & 4.53609 \\ -3.7037 & -5.18519 & 3.7037 & 5.18519 & 5.44331 & 0.907218 & -5.44331 & -0.907218 \\ -5.18519 & -12.5926 & 5.18519 & 12.5926 & 10.8866 & 4.53609 & -10.8866 & -4.53609 \\ -5.44331 & -10.8866 & 5.44331 & 10.8866 & 10. & 3.33333 & -10. & -3.33333 \\ -0.907218 & -4.53609 & 0.907218 & 4.53609 & 3.33333 & 2.22222 & -3.33333 & -2.22222 \\ 5.44331 & 10.8866 & -5.44331 & -10.8866 & -10. & -3.33333 & 10. & 3.33333 \\ 0.907218 & 4.53609 & -0.907218 & -4.53609 & -3.33333 & -2.22222 & 3.33333 & 2.22222 \\ -1.17121 & -5.85607 & 1.17121 & 5.85607 & 4.30331 & 2.86888 & -4.30331 & -2.86888 \\ 7.02728 & 14.0546 & -7.02728 & -14.0546 & -12.9099 & -4.30331 & 12.9099 & 4.30331 \\ -1.17121 & -5.85607 & 1.17121 & 5.85607 & 4.30331 & 2.86888 & -4.30331 & -2.86888 \\ 7.02728 & 14.0546 & -7.02728 & -14.0546 & -12.9099 & -4.30331 & 12.9099 & 4.30331 \end{pmatrix}$$

$$\mathbf{k}_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_q^T =$$

$$(166.667 \quad 166.667 \quad 166.667 \quad 166.667 \quad -204.124 \quad -204.124 \quad -204.124 \quad -204.124 \quad 0. \quad 0. \quad 0. \quad 0.)$$

$$\text{Gauss point} = \{s \rightarrow 0., t \rightarrow 0.774597\} \quad \text{Weight} = 0.493827$$

$$\mathbf{N}^T = \{0.0563508, 0.0563508, 0.443649, 0.443649, \\ -0.0690154, -0.122474, -0.543357, -0.122474, 0., -0.122474, 0., -0.122474\}$$

$$\partial \mathbf{N}^T / \partial s = (-0.0563508 \quad 0.0563508 \quad 0.443649 \quad -0.443649 \quad 0. \quad -0.122474 \quad 0. \quad 0.122474 \quad -0.0890985$$

$$\partial \mathbf{N}^T / \partial t =$$

$$(-0.25 \quad -0.25 \quad 0.25 \quad 0.25 \quad 0.306186 \quad 0.474342 \quad -0.306186 \quad 0.474342 \quad 0. \quad 0.316228 \quad 0. \quad 0.316228)$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 59.9142 & 0. \\ -59.9142 & 133.333 \end{pmatrix} \quad \det \mathbf{J} = 0.000125179$$

$$\mathbf{B}^T = \begin{pmatrix} -3.37622 & 3.37622 & 26.5809 & -26.5809 & 0. & -7.33796 & 0. & 7.33796 & -5.37 \\ -29.9571 & -36.7096 & 6.75243 & 59.9142 & 40.8248 & 70.5835 & -40.8248 & 55.9076 & 5.37 \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$\mathbf{k}_k = \begin{pmatrix} 2.52814 & 3.02742 & -0.812345 & -4.74321 & -3.40207 & -5.81304 & 3.40207 & -4.72788 \\ 3.02742 & 3.78038 & -0.439895 & -6.3679 & -4.16891 & -7.27669 & 4.16891 & -5.6402 \\ -0.812345 & -0.439895 & 2.09227 & -0.840027 & 0.766838 & 0.783233 & -0.766838 & 1.59273 \\ -4.74321 & -6.3679 & -0.840027 & 11.9511 & 6.80414 & 12.3065 & -6.80414 & 8.77535 \\ -3.40207 & -4.16891 & 0.766838 & 6.80414 & 4.63626 & 8.01579 & -4.63626 & 6.34913 \\ -5.81304 & -7.27669 & 0.783233 & 12.3065 & 8.01579 & 14.0086 & -8.01579 & 10.8274 \\ 3.40207 & 4.16891 & -0.766838 & -6.80414 & -4.63626 & -8.01579 & 4.63626 & -6.34913 \\ -4.72788 & -5.6402 & 1.59273 & 8.77535 & 6.34913 & 10.8274 & -6.34913 & 8.8446 \\ -0.39472 & -0.595264 & -0.294448 & 1.28443 & 0.606238 & 1.15711 & -0.606238 & 0.72124 \\ -4.05622 & -5.12388 & 0.38724 & 8.79286 & 5.62164 & 9.86924 & -5.62164 & 7.54871 \\ -3.10762 & -4.6865 & -2.31818 & 10.1123 & 4.77291 & 9.10994 & -4.77291 & 5.67836 \\ -2.97106 & -3.48738 & 1.19673 & 5.26171 & 3.95497 & 6.68811 & -3.95497 & 5.56591 \end{pmatrix}$$

$$\mathbf{k}_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_q^T = (17.4171 \quad 17.4171 \quad 137.125 \quad 137.125 \quad -21.3315 \quad -37.8549 \quad -167.943 \quad -37.8549 \quad 0. \quad -37.8549)$$

$$\text{Gauss point} = \{s \rightarrow 0.774597, t \rightarrow -0.774597\} \quad \text{Weight} = 0.308642$$

$$\mathbf{N}^T = \{0.1, 0.787298, 0.1, 0.0127017, -0.217343, -0.217343, -0.0276062, -0.0276062, -0.217343, 0.217343, -0.0276062, 0.0276062\}$$

$$\partial \mathbf{N}^T / \partial s = (-0.443649 \quad 0.443649 \quad 0.0563508 \quad -0.0563508 \quad 0.841765 \quad -0.122474 \quad 0.106918 \quad 0.122474 \quad -0.841765 \quad 0.122474 \quad -0.106918 \quad -0.122474)$$

$$\partial \mathbf{N}^T / \partial t = (-0.0563508 \quad -0.443649 \quad 0.443649 \quad 0.0563508 \quad 0.122474 \quad -0.841765 \quad -0.122474 \quad -0.106918 \quad 0.841765 \quad -0.122474 \quad 0.106918 \quad 0.122474)$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 35.3239 & 0. \\ -7.96212 & 133.333 \end{pmatrix} \quad \det \mathbf{J} = 0.000212321$$

$$\mathbf{B}^T = \begin{pmatrix} -15.6714 & 15.6714 & 1.99053 & -1.99053 & 29.7344 & -4.32627 & 3.77676 & 4.32627 & 1 \\ -3.98106 & -62.6856 & 58.7046 & 7.96212 & 9.6277 & -111.26 & -17.1812 & -15.2309 & 1 \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$\mathbf{k}_k = \begin{pmatrix} 0.770966 & 0.0116842 & -0.781166 & -0.00148408 & -1.48716 & 1.5061 & 0.0271661 \\ 0.0116842 & 12.3119 & -10.7598 & -1.56382 & -0.405588 & 20.3669 & 3.35055 \\ -0.781166 & -10.7598 & 10.1743 & 1.36667 & 1.84123 & -19.2861 & -2.95214 \\ -0.00148408 & -1.56382 & 1.36667 & 0.198631 & 0.0515164 & -2.58694 & -0.425576 \\ -1.48716 & -0.405588 & 1.84123 & 0.0515164 & 2.88057 & -3.53815 & -0.156634 \\ 1.5061 & 20.3669 & -19.2861 & -2.58694 & -3.53815 & 36.5592 & 5.5889 \\ 0.0271661 & 3.35055 & -2.95214 & -0.425576 & -0.156634 & 5.5889 & 0.912563 \\ -0.0211247 & 3.01542 & -2.61129 & -0.383009 & -0.0530791 & 4.942 & 0.819869 \\ -1.05534 & -1.27661 & 2.1698 & 0.162151 & 2.07492 & -4.14469 & -0.380212 \\ -1.06689 & -13.4512 & 12.8096 & 1.70853 & 2.47599 & -24.2845 & -3.6934 \\ 0.0820139 & 3.23992 & -2.91041 & -0.411524 & -0.258964 & 5.51186 & 0.884165 \\ 0.0769111 & -2.13701 & 1.78867 & 0.271436 & -0.0818334 & -3.38292 & -0.57911 \end{pmatrix}$$

$$\mathbf{k}_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_q^T = (32.7656 \quad 257.963 \quad 32.7656 \quad 4.16178 \quad -71.2137 \quad -71.2137 \quad -9.04532 \quad -9.04532 \quad -71.2137)$$

Gauss point = {s → 0.774597, t → 0.} Weight = 0.493827

$$\mathbf{N}^T = \{0.0563508, 0.443649, 0.443649, 0.0563508, \\ -0.122474, -0.543357, -0.122474, -0.0690154, -0.122474, 0., -0.122474, 0.\}$$

$$\partial \mathbf{N}^T / \partial s = \\ (-0.25 \quad 0.25 \quad 0.25 \quad -0.25 \quad 0.474342 \quad -0.306186 \quad 0.474342 \quad 0.306186 \quad 0.316228 \quad 0. \quad 0.316228 \quad 0.)$$

$$\partial \mathbf{N}^T / \partial t = (-0.0563508 \quad -0.443649 \quad 0.443649 \quad 0.0563508 \quad 0.122474 \quad 0. \quad -0.122474 \quad 0. \quad 0.122474 \quad -$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 44.4444 & 0. \\ -10.0179 & 133.333 \end{pmatrix} \quad \det \mathbf{J} = 0.00016875$$

$$\mathbf{B}^T = \begin{pmatrix} -11.1111 & 11.1111 & 11.1111 & -11.1111 & 21.0819 & -13.6083 & 21.0819 & 13.6083 & 14.05 \\ -5.00896 & -61.6577 & 56.6487 & 10.0179 & 11.578 & 3.06735 & -21.0819 & -3.06735 & 13.16 \end{pmatrix}$$

$$\begin{aligned}
& k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6 \\
& \mathbf{k}_k = \begin{pmatrix} 0.557049 & 0.695191 & -1.52703 & 0.27479 & -1.09589 & 0.509396 & -0.482417 & - \\ 0.695191 & 14.7192 & -12.6352 & -2.77927 & -1.79862 & -1.27623 & 5.75288 & - \\ -1.52703 & -12.6352 & 12.497 & 1.66517 & 3.33796 & 0.0845943 & -3.60007 & - \\ 0.27479 & -2.77927 & 1.66517 & 0.839309 & -0.443457 & 0.682243 & -1.6704 & - \\ -1.09589 & -1.79862 & 3.33796 & -0.443457 & 2.16936 & -0.942652 & 0.751344 & - \\ 0.509396 & -1.27623 & 0.0845943 & 0.682243 & -0.942652 & 0.729727 & -1.31832 & - \\ -0.482417 & 5.75288 & -3.60007 & -1.6704 & 0.751344 & -1.31832 & 3.33333 & - \\ -0.509396 & 1.27623 & -0.0845943 & -0.682243 & 0.942652 & -0.729727 & 1.31832 & - \\ -0.832837 & -2.45766 & 3.38164 & -0.0911478 & 1.68257 & -0.565823 & 0.0705648 & - \\ 1.75682 & 21.6255 & -19.8687 & -3.51364 & -4.06082 & -1.07583 & 7.39415 & - \\ -0.219366 & 5.09384 & -3.55638 & -1.31809 & 0.264561 & -0.941495 & 2.65255 & - \\ 0.223146 & 2.7468 & -2.52366 & -0.446291 & -0.515792 & -0.136648 & 0.939181 & - \end{pmatrix} \\
& \mathbf{k}_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix} \\
& \mathbf{r}_q^T = (23.4795 \quad 184.854 \quad 184.854 \quad 23.4795 \quad -51.031 \quad -226.399 \quad -51.031 \quad -28.7564 \quad -51.031 \quad 0. \quad - \\
& \text{Gauss point} = \{s \rightarrow 0.774597, t \rightarrow 0.774597\} \quad \text{Weight} = 0.308642 \\
& \mathbf{N}^T = \{0.0127017, 0.1, 0.787298, 0.1, -0.0276062, -0.217343, \\
& -0.217343, -0.0276062, -0.0276062, -0.217343, -0.217343, -0.0276062\} \\
& \partial \mathbf{N}^T / \partial s = (-0.0563508 \quad 0.0563508 \quad 0.443649 \quad -0.443649 \quad 0.106918 \quad -0.122474 \quad 0.841765 \quad 0.122474 \\
& \partial \mathbf{N}^T / \partial t = (-0.0563508 \quad -0.443649 \quad 0.443649 \quad 0.0563508 \quad 0.122474 \quad 0.841765 \quad -0.122474 \quad 0.106918 \\
& \mathbf{J}^{-T} = \begin{pmatrix} 59.9142 & 0. \\ -13.5049 & 133.333 \end{pmatrix} \quad \det \mathbf{J} = 0.000125179 \\
& \mathbf{B}^T = \begin{pmatrix} -3.37622 & 3.37622 & 26.5809 & -26.5809 & 6.40592 & -7.33796 & 50.4337 & 7.33796 & 4.27 \\ -6.75243 & -59.9142 & 53.1618 & 13.5049 & 14.886 & 113.889 & -27.6979 & 12.6018 & 15.36 \end{pmatrix}
\end{aligned}$$

$$\begin{aligned}
& k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6 \\
& k_k = \begin{pmatrix} 0.0990899 & 0.683561 & -0.780133 & -0.00251721 & -0.21236 & -1.29396 & 0.0291264 \\ 0.683561 & 6.26088 & -5.38166 & -1.56278 & -1.51302 & -11.9065 & 3.18123 \\ -0.780133 & -5.38166 & 6.14198 & 0.019818 & 1.67191 & 10.1873 & -0.229311 \\ -0.00251721 & -1.56278 & 0.019818 & 1.54548 & 0.0534767 & 3.01318 & -2.98105 \\ -0.21236 & -1.51302 & 1.67191 & 0.0534767 & 0.456606 & 2.86582 & -0.155146 \\ -1.29396 & -11.9065 & 10.1873 & 3.01318 & 2.86582 & 22.6446 & -6.12781 \\ 0.0291264 & 3.18123 & -0.229311 & -2.98105 & -0.155146 & -6.12781 & 5.75602 \\ -0.191015 & -1.26961 & 1.50385 & -0.0432296 & 0.407868 & 2.40163 & 0.0365786 \\ -0.205477 & -1.57569 & 1.61771 & 0.163457 & 0.445281 & 2.98836 & -0.365555 \\ -0.854755 & -8.00949 & 6.72947 & 2.13477 & 1.89757 & 15.2368 & -4.32623 \\ 0.0833207 & 2.68783 & -0.655983 & -2.11517 & -0.244308 & -5.16302 & 4.09947 \\ -0.135228 & -0.774618 & 1.06465 & -0.154802 & 0.284885 & 1.46071 & 0.265409 \end{pmatrix} \\
& k_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix} \\
& r_q^T = (2.45367 \quad 19.3177 \quad 152.088 \quad 19.3177 \quad -5.33288 \quad -41.9857 \quad -41.9857 \quad -5.33288 \quad -5.33288 \quad \dots
\end{aligned}$$

Adding contributions from all Gauss points

$$k_k = \begin{pmatrix} 25.1389 & 19.8611 & -5.97222 & -39.0278 & -29.6466 & -5.44331 & 4.17968 & 5 \\ 19.8611 & 70.1389 & -39.0278 & -50.9722 & -43.8381 & 5.44331 & 32.5627 & 31 \\ -5.97222 & -39.0278 & 44.3056 & 0.694444 & 14.1915 & -20.0722 & -28.383 & -16 \\ -39.0278 & -50.9722 & 0.694444 & 89.3056 & 59.2932 & 20.0722 & -8.35937 & -20 \\ -29.6466 & -43.8381 & 14.1915 & 59.2932 & 58.5952 & 4.7619 & -13.6905 & -34 \\ -5.44331 & 5.44331 & -20.0722 & 20.0722 & 4.7619 & 97.0833 & 5.47619 & 37 \\ 4.17968 & 32.5627 & -28.383 & -8.35937 & -13.6905 & 5.47619 & 49.881 & 24 \\ 5.44331 & 31.299 & -16.6701 & -20.0722 & -34.7619 & 37.9167 & 24.5238 & 97 \\ 7.65472 & -7.65472 & 15.3094 & -15.3094 & -8.97549 & -8.97549 & -16.9059 & 8 \\ -1.31762 & 1.31762 & -2.63523 & 2.63523 & -0.922139 & -15.1692 & 1.84428 & 3 \\ -1.07919 & 1.07919 & -2.15838 & 2.15838 & 6.33202 & 6.33202 & -12.664 & -6 \\ 1.31762 & -1.31762 & 2.63523 & -2.63523 & 0.922139 & -19.6877 & -1.84428 & -15 \end{pmatrix}$$

$$k_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$r_q^T = (937.5 \quad 937.5 \quad 750. \quad 750. \quad -765.466 \quad -688.919 \quad -612.372 \quad -688.919 \quad 0. \quad 59.2927 \quad 0. \quad 59.2927)$$

Natural boundary conditions

Specified NBC values for side 3: $\alpha = -55$ $\beta = 1100$

Interpolation functions for mapping: $\left\{0, 0, \frac{1-a}{2}, \frac{a+1}{2}\right\}$

Interpolation functions for solution: $\left\{0, 0, \frac{1-a}{2}, \frac{a+1}{2}, 0, 0, \frac{\frac{3a^2}{2} - \frac{3}{2}}{\sqrt{6}}, 0, 0, 0, \frac{\frac{5a}{2} - \frac{5a^3}{2}}{\sqrt{10}}, 0\right\}$

$x(a) = 0.045 - 0.015 a$ $y(a) = 0.015$

$J_c = 0.015$

Value in mapped coordinate: $\alpha(a) = -55$ $\beta(a) = 1100$

Gauss point = -0.774597

Weight = 0.555556

$$\mathbf{N}_c^T = \{0., 0., 0.887298, 0.112702, 0., 0., -0.244949, 0., 0., 0., -0.244949, 0.\}$$

$$J_c = 0.015$$

$$\alpha = -55.$$

$$\beta = 1100.$$

$$\mathbf{k}_\alpha = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & -0.360845 & -0.0458333 & 0. & 0. & 0.0996155 & 0. & 0. & 0.0996155 & 0. \\ 0. & 0. & -0.0458333 & -0.0058216 & 0. & 0. & 0.0126528 & 0. & 0. & 0.0126528 & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0.0996155 & 0.0126528 & 0. & 0. & -0.0275 & 0. & 0. & -0.0275 & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0.0996155 & 0.0126528 & 0. & 0. & -0.0275 & 0. & 0. & -0.0275 & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_\beta = \begin{pmatrix} 0. \\ 0. \\ -8.13357 \\ -1.0331 \\ 0. \\ 0. \\ 2.24537 \\ 0. \\ 0. \\ 0. \\ 2.24537 \\ 0. \end{pmatrix}$$

Gauss point = $0.$

Weight = 0.888889

$$\mathbf{N}_c^T = \{0., 0., 0.5, 0.5, 0., 0., -0.612372, 0., 0., 0., 0., 0.\}$$

$$J_c = 0.015$$

$$\alpha = -55.$$

$$\beta = 1100.$$

$$\mathbf{k}_\alpha =$$

$$\begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & -0.183333 & -0.183333 & 0. & 0. & 0.224537 & 0. & 0. & 0. & 0. \\ 0. & 0. & -0.183333 & -0.183333 & 0. & 0. & 0.224537 & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0.224537 & 0.224537 & 0. & 0. & -0.275 & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_\beta = \begin{pmatrix} 0. \\ 0. \\ -7.33333 \\ -7.33333 \\ 0. \\ 0. \\ 8.98146 \\ 0. \\ 0. \\ 0. \\ 0. \\ 0. \end{pmatrix}$$

$$\text{Gauss point} = 0.774597$$

$$\text{Weight} = 0.555556$$

$$\mathbf{N}_c^T = \{0., 0., 0.112702, 0.887298, 0., 0., -0.244949, 0., 0., 0., 0.244949, 0.\}$$

$$J_c = 0.015$$

$$\alpha = -55.$$

$$\beta = 1100.$$

$$\mathbf{k}_\alpha = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & -0.0058216 & -0.0458333 & 0. & 0. & 0.0126528 & 0. & 0. & -0.0126528 \\ 0. & 0. & -0.0458333 & -0.360845 & 0. & 0. & 0.0996155 & 0. & 0. & -0.0996155 \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0.0126528 & 0.0996155 & 0. & 0. & -0.0275 & 0. & 0. & 0.0275 \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & -0.0126528 & -0.0996155 & 0. & 0. & 0.0275 & 0. & 0. & -0.0275 \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_\beta = \begin{pmatrix} 0. \\ 0. \\ -1.0331 \\ -8.13357 \\ 0. \\ 0. \\ 2.24537 \\ 0. \\ 0. \\ 0. \\ -2.24537 \\ 0. \end{pmatrix}$$

Adding contributions from all Gauss points

$$\mathbf{k}_\alpha = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & -0.55 & -0.275 & 0. & 0. & 0.336805 & 0. & 0. & 0.0869626 \\ 0. & 0. & -0.275 & -0.55 & 0. & 0. & 0.336805 & 0. & 0. & -0.0869626 \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0.336805 & 0.336805 & 0. & 0. & -0.33 & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0.0869626 & -0.0869626 & 0. & 0. & 0. & 0. & 0. & -0.055 \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_\beta = \begin{pmatrix} 0. \\ 0. \\ -16.5 \\ -16.5 \\ 0. \\ 0. \\ 13.4722 \\ 0. \\ 0. \\ 0. \\ 0. \\ 0. \\ 0. \end{pmatrix}$$

$$\begin{pmatrix} 25.1389 & 19.8611 & -5.97222 & -39.0278 & -29.6466 & -5.44331 & 4.17968 & 5.44331 & 7.6 \\ 19.8611 & 70.1389 & -39.0278 & -50.9722 & -43.8381 & 5.44331 & 32.5627 & 31.299 & -7.6 \\ -5.97222 & -39.0278 & 43.7556 & 0.419444 & 14.1915 & -20.0722 & -28.0462 & -16.6701 & 15.3 \\ -39.0278 & -50.9722 & 0.419444 & 88.7556 & 59.2932 & 20.0722 & -8.02256 & -20.0722 & -15.3 \\ -29.6466 & -43.8381 & 14.1915 & 59.2932 & 58.5952 & 4.7619 & -13.6905 & -34.7619 & -8.9 \\ -5.44331 & 5.44331 & -20.0722 & 20.0722 & 4.7619 & 97.0833 & 5.47619 & 37.9167 & -8.9 \\ 4.17968 & 32.5627 & -28.0462 & -8.02256 & -13.6905 & 5.47619 & 49.551 & 24.5238 & -16.9 \\ 5.44331 & 31.299 & -16.6701 & -20.0722 & -34.7619 & 37.9167 & 24.5238 & 97.0833 & 8.9 \\ 7.65472 & -7.65472 & 15.3094 & -15.3094 & -8.97549 & -8.97549 & -16.9059 & 8.97549 & 30.1 \\ -1.31762 & 1.31762 & -2.63523 & 2.63523 & -0.922139 & -15.1692 & 1.84428 & 3.55023 & 0.2 \\ -1.07919 & 1.07919 & -2.07142 & 2.07142 & 6.33202 & 6.33202 & -12.664 & -6.33202 & 7.1 \\ 1.31762 & -1.31762 & 2.63523 & -2.63523 & 0.922139 & -19.6877 & -1.84428 & -15.1692 & -0.2 \end{pmatrix}$$

Equations for element 2

Element coordinates: ({0, 0} {0.03, 0.015} {0.03, 0.03} {0, 0.03})

$$x(s,t) = 0.015s + 0.015$$

$$y(s,t) = -0.00375ts + 0.00375s + 0.01125t + 0.01875$$

$$\mathbf{J} = \begin{pmatrix} 0.015 & 0 \\ 0.00375 - 0.00375t & 0.01125 - 0.00375s \end{pmatrix}$$

$$\det \mathbf{J} = 0.00016875 - 0.00005625s$$

Given element data

$$k_x = 45 \quad k_y = 45 \quad p = 0 \quad q = 5000000$$

Element data in mapped coordinates

$$k_x = 45 \quad k_y = 45 \quad p = 0 \quad q = 5000000$$

$$\text{Gauss point} = \{s \rightarrow -0.774597, t \rightarrow -0.774597\} \quad \text{Weight} = 0.308642$$

$$\mathbf{N}^T = \{0.787298, 0.1, 0.0127017, 0.1, -0.217343, -0.0276062, -0.0276062, -0.217343, 0.217343, 0.0276062, 0.0276062, 0.217343\}$$

$$\partial \mathbf{N}^T / \partial s = \{-0.443649 \quad 0.443649 \quad 0.0563508 \quad -0.0563508 \quad -0.841765 \quad -0.122474 \quad -0.106918 \quad 0.122474 \quad -0.106918 \quad 0.122474 \quad -0.106918 \quad 0.122474\}$$

$$\partial \mathbf{N}^T / \partial t = \{-0.443649 \quad -0.0563508 \quad 0.0563508 \quad 0.443649 \quad 0.122474 \quad -0.106918 \quad -0.122474 \quad -0.841765 \quad -0.122474 \quad 0.106918 \quad 0.122474 \quad -0.443649\}$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 66.6667 & -31.3428 \\ 0. & 70.6477 \end{pmatrix} \quad \det \mathbf{J} = 0.000212321$$

$$\mathbf{B}^T = \begin{pmatrix} -15.6714 & 31.3428 & 1.99053 & -17.6619 & -59.9564 & -4.81385 & -3.28919 & 34.5482 & 41.2 \\ -31.3428 & -3.98106 & 3.98106 & 31.3428 & 8.65254 & -7.55353 & -8.65254 & -59.4688 & -8.6 \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$\mathbf{k}_k = \begin{pmatrix} 3.62115 & -1.0805 & -0.459946 & -2.0807 & 1.97106 & 0.920614 & 0.951733 & 3.89992 \\ -1.0805 & 2.94366 & 0.137242 & -2.00039 & -5.64316 & -0.356253 & -0.20243 & 3.89992 \\ -0.459946 & 0.137242 & 0.0584208 & 0.264284 & -0.250358 & -0.116933 & -0.120886 & -0.459946 \\ -2.0807 & -2.00039 & 0.264284 & 3.81681 & 3.92246 & -0.447428 & -0.628416 & -7.2959 \\ 1.97106 & -5.64316 & -0.250358 & 3.92246 & 10.8214 & 0.658383 & 0.360772 & -7.6257 \\ 0.920614 & -0.356253 & -0.116933 & -0.447428 & 0.658383 & 0.236587 & 0.239424 & 0.834212 \\ 0.951733 & -0.20243 & -0.120886 & -0.628416 & 0.360772 & 0.239424 & 0.252678 & 1.18228 \\ 3.89992 & 3.89134 & -0.495355 & -7.2959 & -7.6257 & 0.834212 & 1.18228 & 13.9134 \\ -1.1066 & 3.91423 & 0.140557 & -2.94819 & -7.51409 & -0.392842 & -0.179334 & 5.71409 \\ -0.73952 & 0.489056 & 0.0939313 & 0.156532 & -0.920126 & -0.19636 & -0.186015 & -0.205696 \\ -0.841931 & -0.0171721 & 0.106939 & 0.752164 & 0.0593108 & -0.205696 & -0.229632 & -1.40593 \\ -2.47417 & -2.84578 & 0.314261 & 5.00569 & 5.565 & -0.517506 & -0.761786 & -9.517506 \end{pmatrix}$$

$$\mathbf{k}_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_q^T = (257.963 \quad 32.7656 \quad 4.16178 \quad 32.7656 \quad -71.2137 \quad -9.04532 \quad -9.04532 \quad -71.2137 \quad 71.2137 \quad 9.04532)$$

$$\text{Gauss point} = \{s \rightarrow -0.774597, t \rightarrow 0.\} \quad \text{Weight} = 0.493827$$

$$\mathbf{N}^T = \{0.443649, 0.0563508, 0.0563508, 0.443649, \\ -0.122474, -0.0690154, -0.122474, -0.543357, 0.122474, 0., 0.122474, 0.\}$$

$$\frac{\partial \mathbf{N}^T}{\partial s} = \\ (-0.25 \quad 0.25 \quad 0.25 \quad -0.25 \quad -0.474342 \quad -0.306186 \quad -0.474342 \quad 0.306186 \quad 0.316228 \quad 0. \quad 0.316228 \quad 0.)$$

$$\frac{\partial \mathbf{N}^T}{\partial t} = (-0.443649 \quad -0.0563508 \quad 0.0563508 \quad 0.443649 \quad 0.122474 \quad 0. \quad -0.122474 \quad 0. \quad -0.122474$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 66.6667 & -17.6619 \\ 0. & 70.6477 \end{pmatrix} \quad \det \mathbf{J} = 0.000212321$$

$$\mathbf{B}^T = \begin{pmatrix} -8.83097 & 17.6619 & 15.6714 & -24.5024 & -33.7859 & -20.4124 & -29.4596 & 20.4124 & 23. \\ -31.3428 & -3.98106 & 3.98106 & 31.3428 & 8.65254 & 0. & -8.65254 & 0. & -8. \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$\mathbf{k}_k = \begin{pmatrix} 5.00303 & -0.147183 & -1.24171 & -3.61414 & 0.128182 & 0.850517 & 2.50705 & -0.850517 \\ -0.147183 & 1.54661 & 1.23117 & -2.6306 & -2.97802 & -1.70103 & -2.29244 & 1.70103 \\ -1.24171 & 1.23117 & 1.23355 & -1.22301 & -2.33566 & -1.50933 & -2.34082 & 1.50933 \\ -3.61414 & -2.6306 & -1.22301 & 7.46774 & 5.18549 & 2.35984 & 2.12621 & -2.35984 \\ 0.128182 & -2.97802 & -2.33566 & 5.18549 & 5.73906 & 3.25395 & 4.34293 & -3.25395 \\ 0.850517 & -1.70103 & -1.50933 & 2.35984 & 3.25395 & 1.96594 & 2.83728 & -1.96594 \\ 2.50705 & -2.29244 & -2.34082 & 2.12621 & 4.34293 & 2.83728 & 4.44806 & -2.83728 \\ -0.850517 & 1.70103 & 1.50933 & -2.35984 & -3.25395 & -1.96594 & -2.83728 & 1.96594 \\ 0.311023 & 2.09961 & 1.55624 & -3.96688 & -4.05873 & -2.23874 & -2.87776 & 2.23874 \\ 0.865297 & 0.249373 & -0.00187723 & -1.11279 & -0.507832 & -0.15156 & 0.0382421 & 0.15156 \\ -2.06784 & 1.41403 & 1.5614 & -0.907594 & -2.6626 & -1.82208 & -2.9829 & 1.82208 \\ 6.81247 & 1.96331 & -0.0147794 & -8.761 & -3.99816 & -1.19323 & 0.301079 & 1.19323 \end{pmatrix}$$

$$\mathbf{k}_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_q^T = (232.583 \quad 29.5419 \quad 29.5419 \quad 232.583 \quad -64.2072 \quad -36.1813 \quad -64.2072 \quad -284.855 \quad 64.2072 \quad 0.)$$

$$\text{Gauss point} = \{s \rightarrow -0.774597, t \rightarrow 0.774597\} \quad \text{Weight} = 0.308642$$

$$\mathbf{N}^T = \{0.1, 0.0127017, 0.1, 0.787298, -0.0276062, -0.0276062, -0.217343, -0.217343, 0.0276062, -0.0276062, 0.217343, -0.217343\}$$

$$\partial \mathbf{N}^T / \partial s = (-0.0563508 \quad 0.0563508 \quad 0.443649 \quad -0.443649 \quad -0.106918 \quad -0.122474 \quad -0.841765 \quad 0.122474$$

$$\partial \mathbf{N}^T / \partial t = (-0.443649 \quad -0.0563508 \quad 0.0563508 \quad 0.443649 \quad 0.122474 \quad 0.106918 \quad -0.122474 \quad 0.841765$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 66.6667 & -3.98106 \\ 0. & 70.6477 \end{pmatrix} \quad \det \mathbf{J} = 0.000212321$$

$$\mathbf{B}^T = \begin{pmatrix} -1.99053 & 3.98106 & 29.3523 & -31.3428 & -7.61546 & -8.59061 & -55.6301 & 4.81385 & 5. \\ -31.3428 & -3.98106 & 3.98106 & 31.3428 & 8.65254 & 7.55353 & -8.65254 & 59.4688 & -8. \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$\mathbf{k}_k = \begin{pmatrix} 2.9086 & 0.344589 & -0.540251 & -2.71294 & -0.755026 & -0.647723 & 1.12627 & -5.52477 \\ 0.344589 & 0.0934733 & 0.297852 & -0.735914 & -0.190982 & -0.189528 & -0.551505 & -0.641636 \\ -0.540251 & 0.297852 & 2.58738 & -2.34498 & -0.557593 & -0.654901 & -4.91675 & 1.11482 \\ -2.71294 & -0.735914 & -2.34498 & 5.79384 & 1.5036 & 1.49215 & 4.34199 & 5.05159 \\ -0.755026 & -0.190982 & -0.557593 & 1.5036 & 0.391796 & 0.385654 & 1.02852 & 1.40927 \\ -0.647723 & -0.189528 & -0.654901 & 1.49215 & 0.385654 & 0.385877 & 1.21654 & 1.20271 \\ 1.12627 & -0.551505 & -4.91675 & 4.34199 & 1.02852 & 1.21654 & 9.34677 & -2.30708 \\ -5.52477 & -0.641636 & 1.11482 & 5.05159 & 1.40927 & 1.2027 & -2.30708 & 10.4973 \\ 0.768973 & 0.163089 & 0.351937 & -1.284 & -0.338439 & -0.325464 & -0.638754 & -1.443 \\ -0.41584 & -0.158304 & -0.672179 & 1.24632 & 0.318223 & 0.326199 & 1.25751 & 0.763 \\ -1.01647 & 0.331902 & 3.29763 & -2.61306 & -0.608442 & -0.742665 & -6.27811 & 2.041 \\ -3.69916 & -0.395806 & 0.978793 & 3.11617 & 0.878393 & 0.73285 & -1.98453 & 7.036 \end{pmatrix}$$

$$\mathbf{k}_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_q^T = (32.7656 \quad 4.16178 \quad 32.7656 \quad 257.963 \quad -9.04532 \quad -9.04532 \quad -71.2137 \quad -71.2137 \quad 9.04532 \quad -9.04532 \quad 4.16178 \quad 32.7656 \quad 257.963)$$

$$\text{Gauss point} = \{s \rightarrow 0., t \rightarrow -0.774597\} \quad \text{Weight} = 0.493827$$

$$\mathbf{N}^T = \{0.443649, 0.443649, 0.0563508, 0.0563508, \\ -0.543357, -0.122474, -0.0690154, -0.122474, 0., 0.122474, 0., 0.122474\}$$

$$\partial \mathbf{N}^T / \partial s = (-0.443649 \quad 0.443649 \quad 0.0563508 \quad -0.0563508 \quad 0. \quad -0.122474 \quad 0. \quad 0.122474 \quad -0.701471 \quad 0.701471 \quad 0.0690154 \quad -0.122474 \quad -0.543357)$$

$$\partial \mathbf{N}^T / \partial t =$$

$$(-0.25 \quad -0.25 \quad 0.25 \quad 0.25 \quad 0.306186 \quad -0.474342 \quad -0.306186 \quad -0.474342 \quad 0. \quad 0.316228 \quad 0. \quad 0.316228)$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 66.6667 & -39.4355 \\ 0. & 88.8889 \end{pmatrix} \quad \det \mathbf{J} = 0.00016875$$

$$\mathbf{B}^T = \begin{pmatrix} -19.7177 & 39.4355 & -6.10215 & -13.6156 & -12.0746 & 10.5409 & 12.0746 & 26.8709 & -46. \\ -22.2222 & -22.2222 & 22.2222 & 22.2222 & 27.2166 & -42.1637 & -27.2166 & -42.1637 & 0. \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$\mathbf{k}_k = \begin{pmatrix} 3.30981 & -1.06407 & -1.40065 & -0.845094 & -1.37523 & 2.73423 & 1.37523 & 1.52677 \\ -1.06407 & 7.68369 & -2.75426 & -3.86537 & -4.05367 & 5.07247 & 4.05367 & 7.48739 \\ -1.40065 & -2.75426 & 1.99149 & 2.16342 & 2.54435 & -3.75485 & -2.54435 & -4.12853 \\ -0.845094 & -3.86537 & 2.16342 & 2.54704 & 2.88456 & -4.05185 & -2.88456 & -4.88563 \\ -1.37523 & -4.05367 & 2.54435 & 2.88456 & 3.32451 & -4.78061 & -3.32451 & -5.52002 \\ 2.73423 & 5.07247 & -3.75485 & -4.05185 & -4.78061 & 7.08333 & 4.78061 & 7.72883 \\ 1.37523 & 4.05367 & -2.54435 & -2.88456 & -3.32451 & 4.78061 & 3.32451 & 5.52002 \\ 1.52677 & 7.48739 & -4.12853 & -4.88563 & -5.52002 & 7.72883 & 5.52002 & 9.37433 \\ 3.45786 & -6.91571 & 1.07012 & 2.38774 & 2.1175 & -1.84854 & -2.1175 & -4.71228 \\ -2.02406 & -2.97916 & 2.44095 & 2.56227 & 3.06383 & -4.61464 & -3.06383 & -4.8783 \\ 0.439205 & -0.87841 & 0.135923 & 0.303282 & 0.268957 & -0.234795 & -0.268957 & -0.59853 \\ -0.816603 & -5.39408 & 2.81463 & 3.39605 & 3.80325 & -5.26014 & -3.80325 & -6.5238 \end{pmatrix}$$

$$\mathbf{k}_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_q^T = (184.854 \quad 184.854 \quad 23.4795 \quad 23.4795 \quad -226.399 \quad -51.031 \quad -28.7564 \quad -51.031 \quad 0. \quad 51.031 \quad 0.)$$

$$\text{Gauss point} = \{s \rightarrow 0., t \rightarrow 0.\} \quad \text{Weight} = 0.790123$$

$$\mathbf{N}^T = \{0.25, 0.25, 0.25, 0.25, -0.306186, -0.306186, -0.306186, -0.306186, 0., 0., 0., 0.\}$$

$$\begin{aligned}
& \partial \mathbf{N}^T / \partial s = \\
& (-0.25 \quad 0.25 \quad 0.25 \quad -0.25 \quad 0. \quad -0.306186 \quad 0. \quad 0.306186 \quad -0.395285 \quad 0. \quad -0.395285 \quad 0.) \\
& \partial \mathbf{N}^T / \partial t = (-0.25 \quad -0.25 \quad 0.25 \quad 0.25 \quad 0.306186 \quad 0. \quad -0.306186 \quad 0. \quad 0. \quad -0.395285 \quad 0. \quad -0.395285) \\
& \mathbf{J}^{-T} = \begin{pmatrix} 66.6667 & -22.2222 \\ 0. & 88.8889 \end{pmatrix} \quad \det \mathbf{J} = 0.00016875 \\
& \mathbf{B}^T = \begin{pmatrix} -11.1111 & 22.2222 & 11.1111 & -22.2222 & -6.80414 & -20.4124 & 6.80414 & 20.4124 & -26.35 \\ -22.2222 & -22.2222 & 22.2222 & 22.2222 & 27.2166 & 0. & -27.2166 & 0. & 0. \end{pmatrix} \\
& k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6 \\
& \mathbf{k}_k = \begin{pmatrix} 3.7037 & 1.48148 & -3.7037 & -1.48148 & -3.17526 & 1.36083 & 3.17526 & -1.36083 \\ 1.48148 & 5.92593 & -1.48148 & -5.92593 & -4.53609 & -2.72166 & 4.53609 & 2.72166 \\ -3.7037 & -1.48148 & 3.7037 & 1.48148 & 3.17526 & -1.36083 & -3.17526 & 1.36083 \\ -1.48148 & -5.92593 & 1.48148 & 5.92593 & 4.53609 & 2.72166 & -4.53609 & -2.72166 \\ -3.17526 & -4.53609 & 3.17526 & 4.53609 & 4.72222 & 0.833333 & -4.72222 & -0.833333 \\ 1.36083 & -2.72166 & -1.36083 & 2.72166 & 0.833333 & 2.5 & -0.833333 & -2.5 \\ 3.17526 & 4.53609 & -3.17526 & -4.53609 & -4.72222 & -0.833333 & 4.72222 & 0.833333 \\ -1.36083 & 2.72166 & 1.36083 & -2.72166 & -0.833333 & -2.5 & 0.833333 & 2.5 \\ 1.75682 & -3.51364 & -1.75682 & 3.51364 & 1.07583 & 3.22749 & -1.07583 & -3.22749 \\ 4.09925 & 5.85607 & -4.09925 & -5.85607 & -6.09636 & -1.07583 & 6.09636 & 1.07583 \\ 1.75682 & -3.51364 & -1.75682 & 3.51364 & 1.07583 & 3.22749 & -1.07583 & -3.22749 \\ 4.09925 & 5.85607 & -4.09925 & -5.85607 & -6.09636 & -1.07583 & 6.09636 & 1.07583 \end{pmatrix} \\
& \mathbf{k}_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix} \\
& \mathbf{r}_q^T = \\
& (166.667 \quad 166.667 \quad 166.667 \quad 166.667 \quad -204.124 \quad -204.124 \quad -204.124 \quad -204.124 \quad 0. \quad 0. \quad 0. \quad 0.) \\
& \text{Gauss point} = \{s \rightarrow 0., t \rightarrow 0.774597\} \quad \text{Weight} = 0.493827
\end{aligned}$$

$$\mathbf{N}^T = \{0.0563508, 0.0563508, 0.443649, 0.443649, \\ -0.0690154, -0.122474, -0.543357, -0.122474, 0., -0.122474, 0., -0.122474\}$$

$$\partial \mathbf{N}^T / \partial s = (-0.0563508 \quad 0.0563508 \quad 0.443649 \quad -0.443649 \quad 0. \quad -0.122474 \quad 0. \quad 0.122474 \quad -0.0890985$$

$$\partial \mathbf{N}^T / \partial t = \\ (-0.25 \quad -0.25 \quad 0.25 \quad 0.25 \quad 0.306186 \quad 0.474342 \quad -0.306186 \quad 0.474342 \quad 0. \quad 0.316228 \quad 0. \quad 0.316228)$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 66.6667 & -5.00896 \\ 0. & 88.8889 \end{pmatrix} \quad \det \mathbf{J} = 0.00016875$$

$$\mathbf{B}^T = \begin{pmatrix} -2.50448 & 5.00896 & 28.3244 & -30.8289 & -1.53368 & -10.5409 & 1.53368 & 5.78901 & -5. \\ -22.2222 & -22.2222 & 22.2222 & 22.2222 & 27.2166 & 42.1637 & -27.2166 & 42.1637 & 0. \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$\mathbf{k}_k = \begin{pmatrix} 1.87537 & 1.80481 & -2.11787 & -1.56231 & -2.25364 & -3.41464 & 2.25364 & -3.56801 \\ 1.80481 & 1.94594 & -1.31982 & -2.43093 & -2.29685 & -3.71164 & 2.29685 & -3.4049 \\ -2.11787 & -1.31982 & 4.86036 & -1.42268 & 2.10514 & 2.39402 & -2.10514 & 4.12853 \\ -1.56231 & -2.43093 & -1.42268 & 5.41592 & 2.44535 & 4.73226 & -2.44535 & 2.84439 \\ -2.25364 & -2.29685 & 2.10514 & 2.44535 & 2.7866 & 4.36394 & -2.7866 & 4.27002 \\ -3.41464 & -3.71164 & 2.39402 & 4.73226 & 4.36394 & 7.08333 & -4.36394 & 6.43701 \\ 2.25364 & 2.29685 & -2.10514 & -2.44535 & -2.7866 & -4.36394 & 2.7866 & -4.27002 \\ -3.56801 & -3.4049 & 4.12853 & 2.84439 & 4.27002 & 6.43784 & -4.27002 & 6.79202 \\ 0.0557864 & -0.111573 & -0.630915 & 0.686701 & 0.034162 & 0.234795 & -0.034162 & -0.12853 \\ -2.25087 & -2.52555 & 1.30693 & 3.46949 & 2.92495 & 4.82981 & -2.92495 & 4.23202 \\ 0.439205 & -0.87841 & -4.96718 & 5.40639 & 0.268957 & 1.84854 & -0.268957 & -1.01505 \\ -2.40424 & -2.21881 & 3.04144 & 1.58161 & 2.83103 & 4.18431 & -2.83103 & 4.58701 \end{pmatrix}$$

$$\mathbf{k}_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_q^T = (23.4795 \quad 23.4795 \quad 184.854 \quad 184.854 \quad -28.7564 \quad -51.031 \quad -226.399 \quad -51.031 \quad 0. \quad -51.031 \quad ($$

Gauss point = {s → 0.774597, t → -0.774597} Weight = 0.308642

$$\mathbf{N}^T = \{0.1, 0.787298, 0.1, 0.0127017, -0.217343, -0.217343, -0.0276062, -0.0276062, -0.217343, 0.217343, -0.0276062, 0.0276062\}$$

$$\partial \mathbf{N}^T / \partial s = (-0.443649 \quad 0.443649 \quad 0.0563508 \quad -0.0563508 \quad 0.841765 \quad -0.122474 \quad 0.106918 \quad 0.122474 \quad -0.841765 \quad 0.122474 \quad -0.106918 \quad -0.122474)$$

$$\partial \mathbf{N}^T / \partial t = (-0.0563508 \quad -0.443649 \quad 0.443649 \quad 0.0563508 \quad 0.122474 \quad -0.841765 \quad -0.122474 \quad -0.106918 \quad 0.841765 \quad -0.122474 \quad 0.106918 \quad 0.122474)$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 66.6667 & -53.1618 \\ 0. & 119.828 \end{pmatrix} \quad \det \mathbf{J} = 0.000125179$$

$$\mathbf{B}^T = \begin{pmatrix} -26.5809 & 53.1618 & -19.8285 & -6.75243 & 49.6067 & 36.5848 & 13.6388 & 13.8489 & 30.9127 & -13.6388 & -13.8489 & -30.9127 \\ -6.75243 & -53.1618 & 53.1618 & 6.75243 & 14.6759 & -100.867 & -14.6759 & -12.8118 & 14.6759 & 100.867 & 12.8118 & -14.6759 \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$\mathbf{k}_k = \begin{pmatrix} 1.30767 & -1.83268 & 0.292235 & 0.232781 & -2.46479 & -0.50655 & -0.458006 & -0.489599 \\ -1.83268 & 9.82716 & -6.74626 & -1.24821 & 3.22854 & 12.7043 & 2.61705 & 2.46417 \\ 0.292235 & -6.74626 & 5.59714 & 0.856888 & -0.353676 & -10.5841 & -1.82663 & -1.66158 \\ 0.232781 & -1.24821 & 0.856888 & 0.158544 & -0.410079 & -1.61366 & -0.332409 & -0.312991 \\ -2.46479 & 3.22854 & -0.353676 & -0.410079 & 4.65285 & 0.581608 & 0.801832 & 0.867515 \\ -0.50655 & 12.7043 & -10.5841 & -1.61366 & 0.581608 & 20.0159 & 3.4412 & 3.12766 \\ -0.458006 & 2.61705 & -1.82663 & -0.332409 & 0.801832 & 3.4412 & 0.697874 & 0.655293 \\ -0.489599 & 2.46417 & -1.66158 & -0.312991 & 0.867515 & 3.12766 & 0.655293 & 0.618205 \\ -1.60033 & 1.49962 & 0.291185 & -0.190476 & 3.03954 & -0.608202 & 0.35827 & 0.417193 \\ 0.211923 & -8.21797 & 6.96223 & 1.04382 & -0.153007 & -13.1708 & -2.2296 & -2.01923 \\ -0.348205 & 2.39744 & -1.74472 & -0.304515 & 0.596915 & 3.29007 & 0.641534 & 0.598205 \\ 0.452176 & -1.89434 & 1.20155 & 0.240612 & -0.813075 & -2.25822 & -0.501399 & -0.478205 \end{pmatrix}$$

$$\mathbf{k}_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_q^T = (19.3177 \quad 152.088 \quad 19.3177 \quad 2.45367 \quad -41.9857 \quad -41.9857 \quad -5.33288 \quad -5.33288 \quad -41.9857 \quad -41.9857 \quad 152.088 \quad 19.3177)$$

Weight = 0.493827

$$\partial \mathbf{N}^T / \partial \mathbf{s} =$$

$$\partial \mathbf{N}^T / \partial t = (-0.0563508 \quad -0.443649 \quad 0.443649 \quad 0.0563508 \quad 0.122474 \quad 0. \quad -0.122474 \quad 0. \quad 0.122474 \quad -$$

$$\mathbf{B}^T = \begin{pmatrix} -14.9786 & 29.9571 & 3.37622 & -18.3548 & 27.9538 & -20.4124 & 35.2918 & 20.4124 & 17.4124 \\ -6.75243 & -53.1618 & 53.1618 & 6.75243 & 14.6759 & 0. & -14.6759 & 0. & 14.6759 \end{pmatrix}$$

$k_x = 45.$	$k_y = 45.$	$p = 0.$	$q = 5. \times 10^6$					
$k_k =$	0.750942	-0.249643	-1.13925	0.637947	-1.44041	0.850517	-1.19482	-0.850517
	-0.249643	10.3582	-7.58038	-2.52814	0.159161	-1.70103	5.1113	1.70103
	-1.13925	-7.58038	7.89344	0.826186	2.43286	-0.191709	-1.83887	0.191709
	0.637947	-2.52814	0.826186	1.064	-1.15161	1.04223	-2.07761	-1.04223
	-1.44041	0.159161	2.43286	-1.15161	2.77285	-1.58728	2.14517	1.58728
	0.850517	-1.70103	-0.191709	1.04223	-1.58728	1.15906	-2.00395	-1.15906
	-1.19482	5.1113	-1.83887	-2.07761	2.14517	-2.00395	4.06384	2.00395
	-0.850517	1.70103	0.191709	-1.04223	1.58728	-1.15906	2.00395	1.15906
	-1.0012	-0.719249	2.33386	-0.613408	1.95318	-0.988743	1.11033	0.988743
	0.703293	14.1817	-12.2331	-2.65182	-1.79751	-1.19323	5.49459	1.19323
	-0.755618	4.23289	-1.93787	-1.53941	1.3255	-1.40541	3.02901	1.40541
	0.08933	1.80131	-1.55381	-0.336826	-0.228314	-0.15156	0.697905	0.15156

[illegible]

Gauss point = {s \rightarrow 0.774597, t \rightarrow 0.774597} Weight = 0.308642

$$\partial \mathbf{N}^T / \partial \mathbf{s} = (-0.0563508 \quad 0.0563508 \quad 0.443649 \quad -0.443649 \quad 0.106918 \quad -0.122474 \quad 0.841765 \quad 0.122474)$$

$$\partial \mathbf{N}^T / \partial t = (-0.0563508 \quad -0.443649 \quad 0.443649 \quad 0.0563508 \quad 0.122474 \quad 0.841765 \quad -0.122474 \quad 0.106918)$$

$$J^{-T} = \begin{pmatrix} 66.6667 & -6.75243 \\ 0 & 119.828 \end{pmatrix} \quad \det J = 0.000125179$$

$$\mathbf{B}^T = \begin{pmatrix} -3.37622 & 6.75243 & 26.5809 & -29.9571 & 6.30088 & -13.8489 & 56.9447 & 7.44301 & 3.92 \\ -6.75243 & -53.1618 & 53.1618 & 6.75243 & 14.6759 & 100.867 & -14.6759 & 12.8118 & 14.67 \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$\mathbf{K}_k = \begin{pmatrix} 0.0990899 & 0.584471 & -0.780133 & 0.0965727 & -0.209277 & -1.10287 & -0.161966 & -0.194097 \\ 0.584471 & 4.99285 & -4.60153 & -0.975796 & -1.28248 & -9.48545 & 2.02497 & -1.09678 \\ -0.780133 & -4.60153 & 6.14198 & -0.760315 & 1.64764 & 8.68286 & 1.27516 & 1.52813 \\ 0.0965727 & -0.975796 & -0.760315 & 1.63954 & -0.155879 & 1.90546 & -3.13816 & -0.237249 \\ -0.209277 & -1.28248 & 1.64764 & -0.155879 & 0.443488 & 2.42197 & 0.249347 & 0.408437 \\ -1.10287 & -9.48545 & 8.68286 & 1.90546 & 2.42197 & 18.0223 & -3.94478 & 2.06757 \\ -0.161966 & 2.02497 & 1.27516 & -3.13816 & 0.249347 & -3.94478 & 6.0122 & 0.409985 \\ -0.194097 & -1.09678 & 1.52813 & -0.237249 & 0.408437 & 2.06757 & 0.409985 & 0.312131 \\ -0.195331 & -1.31037 & 1.53783 & -0.032131 & 0.41746 & 2.47918 & 0.0141179 & 0.312131 \\ -0.719269 & -6.35558 & 5.66279 & 1.41206 & 1.58483 & 12.0804 & -2.89931 & 1.312131 \\ -0.0521652 & 1.80536 & 0.410695 & -2.1639 & 0.0444298 & -3.49439 & 4.16025 & 0.1639 \\ -0.145374 & -0.699235 & 1.14453 & -0.299919 & 0.302106 & 1.31285 & 0.542778 & 0.299919 \end{pmatrix}$$

[illegible]

$$\mathbf{r}_q^T = (2.45367 \quad 19.3177 \quad 152.088 \quad 19.3177 \quad -5.33288 \quad -41.9857 \quad -41.9857 \quad -5.33288 \quad -5.33288 \quad)$$

Adding contributions from all Gauss points

$$\mathbf{k}_k = \begin{pmatrix} 22.5794 & -0.15873 & -11.0913 & -11.3294 & -9.57439 & 1.04492 & 9.57439 & - \\ -0.15873 & 45.3175 & -22.8175 & -22.3413 & -17.5936 & -2.08984 & 17.5936 & \\ -11.0913 & -22.8175 & 34.0675 & -0.15873 & 8.40797 & -7.09574 & -17.5936 & \\ -11.3294 & -22.3413 & -0.15873 & 33.8294 & 18.76 & 8.14067 & -9.57439 & - \\ -9.57439 & -17.5936 & 8.40797 & 18.76 & 35.6548 & 6.13095 & -1.90476 & - \\ 1.04492 & -2.08984 & -7.09574 & 8.14067 & 6.13095 & 58.4524 & 1.36905 & \\ 9.57439 & 17.5936 & -17.5936 & -9.57439 & -1.90476 & 1.36905 & 35.6548 & \\ -7.41165 & 14.8233 & 3.54787 & -10.9595 & -8.69048 & 15.7738 & 1.19048 & \\ 2.447 & -4.894 & 4.894 & -2.447 & -3.27359 & -0.461069 & -5.44062 & \\ -0.269797 & 0.539595 & -0.539595 & 0.269797 & -1.58301 & -3.16601 & 1.58301 & \\ -2.447 & 4.894 & -4.894 & 2.447 & 0.368856 & 0.461069 & -3.27359 & - \\ 1.91368 & -3.82736 & 3.82736 & -1.91368 & 2.24387 & -4.22647 & -2.24387 & - \end{pmatrix}$$

$$\mathbf{k}_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_q^T = (937.5 \quad 750. \quad 750. \quad 937.5 \quad -688.919 \quad -612.372 \quad -688.919 \quad -765.466 \quad 59.2927 \quad 0. \quad 59.2927 \quad 0.)$$

Natural boundary conditions

Specified NBC values for side 2: $\alpha = -55$ $\beta = 1100$

Interpolation functions for mapping: $\left\{0, \frac{1-a}{2}, \frac{a+1}{2}, 0\right\}$

Interpolation functions for solution: $\left\{0, \frac{1-a}{2}, \frac{a+1}{2}, 0, 0, \frac{\frac{3a^2}{2} - \frac{3}{2}}{\sqrt{6}}, 0, 0, 0, \frac{\frac{5a^3}{2} - \frac{5a}{2}}{\sqrt{10}}, 0, 0\right\}$

$$x(a) = 0.03 \quad y(a) = 0.0075 a + 0.0225$$

$$J_c = 0.0075$$

$$\text{Value in mapped coordinate: } \alpha(a) = -55 \quad \beta(a) = 1100$$

$$\text{Gauss point} = -0.774597 \quad \text{Weight} = 0.555556$$

$$\mathbf{N}_c^T = \{0., 0.887298, 0.112702, 0., 0., -0.244949, 0., 0., 0., 0.244949, 0., 0.\}$$

$$J_c = 0.0075 \quad \alpha = -55. \quad \beta = 1100.$$

$$\mathbf{k}_\alpha =$$

$$\begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & -0.180423 & -0.0229167 & 0. & 0. & 0.0498077 & 0. & 0. & -0.0498077 \\ 0. & -0.0229167 & -0.0029108 & 0. & 0. & 0.00632641 & 0. & 0. & -0.00632641 \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0.0498077 & 0.00632641 & 0. & 0. & -0.01375 & 0. & 0. & 0.01375 \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & -0.0498077 & -0.00632641 & 0. & 0. & 0.01375 & 0. & 0. & -0.01375 \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_\beta = \begin{pmatrix} 0. \\ -4.06678 \\ -0.516549 \\ 0. \\ 0. \\ 1.12268 \\ 0. \\ 0. \\ 0. \\ -1.12268 \\ 0. \\ 0. \end{pmatrix}$$

$$\text{Gauss point} = 0. \quad \text{Weight} = 0.888889$$

$$\mathbf{N}_c^T = \{0., 0.5, 0.5, 0., 0., -0.612372, 0., 0., 0., 0., 0., 0.\}$$

$$J_c = 0.0075 \quad \alpha = -55. \quad \beta = 1100.$$

$$\mathbf{k}_\alpha =$$

$$\begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & -0.0916667 & -0.0916667 & 0. & 0. & 0.112268 & 0. & 0. & 0. & 0. & 0. \\ 0. & -0.0916667 & -0.0916667 & 0. & 0. & 0.112268 & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0.112268 & 0.112268 & 0. & 0. & -0.1375 & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix} \quad \mathbf{r}_\beta = \begin{pmatrix} 0. \\ -3.66667 \\ -3.66667 \\ 0. \\ 0. \\ 4.49073 \\ 0. \\ 0. \\ 0. \\ 0. \\ 0. \\ 0. \end{pmatrix}$$

$$\text{Gauss point} = 0.774597 \quad \text{Weight} = 0.555556$$

$$\mathbf{N}_c^T = \{0., 0.112702, 0.887298, 0., 0., -0.244949, 0., 0., 0., -0.244949, 0., 0.\}$$

$$J_c = 0.0075 \quad \alpha = -55. \quad \beta = 1100.$$

$$\mathbf{k}_\alpha =$$

$$\begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & -0.0029108 & -0.0229167 & 0. & 0. & 0.00632641 & 0. & 0. & 0. \\ 0. & -0.0229167 & -0.180423 & 0. & 0. & 0.0498077 & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0.00632641 & 0.0498077 & 0. & 0. & -0.01375 & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0.00632641 & 0.0498077 & 0. & 0. & -0.01375 & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_\beta = \begin{pmatrix} 0. \\ -0.516549 \\ -4.06678 \\ 0. \\ 0. \\ 1.12268 \\ 0. \\ 0. \\ 0. \\ 1.12268 \\ 0. \\ 0. \end{pmatrix}$$

Adding contributions from all Gauss points

$$\mathbf{k}_\alpha = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & -0.275 & -0.1375 & 0. & 0. & 0.168402 & 0. & 0. & -0.0434813 & 0. \\ 0. & -0.1375 & -0.275 & 0. & 0. & 0.168402 & 0. & 0. & 0.0434813 & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0.168402 & 0.168402 & 0. & 0. & -0.165 & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & -0.0434813 & 0.0434813 & 0. & 0. & 0. & 0. & 0. & -0.0275 & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_\beta = \begin{pmatrix} 0. \\ -8.25 \\ -8.25 \\ 0. \\ 0. \\ 6.7361 \\ 0. \\ 0. \\ 0. \\ 0. \\ 0. \\ 0. \\ 0. \end{pmatrix}$$

Specified NBC values for side 3: $\alpha = -55$ $\beta = 1100$

Interpolation functions for mapping: $\left\{0, 0, \frac{1-a}{2}, \frac{a+1}{2}\right\}$

Interpolation functions for solution: $\left\{0, 0, \frac{1-a}{2}, \frac{a+1}{2}, 0, 0, \frac{\frac{3a^2}{2} - \frac{3}{2}}{\sqrt{6}}, 0, 0, 0, \frac{\frac{5a}{2} - \frac{5a^3}{2}}{\sqrt{10}}, 0\right\}$

$x(a) = 0.015 - 0.015 a$ $y(a) = 0.03$

$J_c = 0.015$

Value in mapped coordinate: $\alpha(a) = -55$ $\beta(a) = 1100$

Gauss point = -0.774597 Weight = 0.555556

$$\mathbf{N}_c^T = \{0., 0., 0.887298, 0.112702, 0., 0., -0.244949, 0., 0., 0., -0.244949, 0.\}$$

$$J_c = 0.015 \quad \alpha = -55. \quad \beta = 1100.$$

$$\mathbf{k}_\alpha = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & -0.360845 & -0.0458333 & 0. & 0. & 0.0996155 & 0. & 0. & 0.0996155 & 0. \\ 0. & 0. & -0.0458333 & -0.0058216 & 0. & 0. & 0.0126528 & 0. & 0. & 0.0126528 & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0.0996155 & 0.0126528 & 0. & 0. & -0.0275 & 0. & 0. & -0.0275 & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0.0996155 & 0.0126528 & 0. & 0. & -0.0275 & 0. & 0. & -0.0275 & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_\beta = \begin{pmatrix} 0. \\ 0. \\ -8.13357 \\ -1.0331 \\ 0. \\ 0. \\ 2.24537 \\ 0. \\ 0. \\ 0. \\ 2.24537 \\ 0. \end{pmatrix}$$

$$\text{Gauss point} = 0. \quad \text{Weight} = 0.888889$$

$$\mathbf{N}_c^T = \{0., 0., 0.5, 0.5, 0., 0., -0.612372, 0., 0., 0., 0., 0.\}$$

$$J_c = 0.015 \quad \alpha = -55. \quad \beta = 1100.$$

$$\mathbf{k}_\alpha =$$

$$\begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & -0.183333 & -0.183333 & 0. & 0. & 0.224537 & 0. & 0. & 0. & 0. \\ 0. & 0. & -0.183333 & -0.183333 & 0. & 0. & 0.224537 & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0.224537 & 0.224537 & 0. & 0. & -0.275 & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_\beta = \begin{pmatrix} 0. \\ 0. \\ -7.33333 \\ -7.33333 \\ 0. \\ 0. \\ 8.98146 \\ 0. \\ 0. \\ 0. \\ 0. \\ 0. \end{pmatrix}$$

$$\text{Gauss point} = 0.774597$$

$$\text{Weight} = 0.555556$$

$$\mathbf{N}_c^T = \{0., 0., 0.112702, 0.887298, 0., 0., -0.244949, 0., 0., 0., 0.244949, 0.\}$$

$$J_c = 0.015$$

$$\alpha = -55.$$

$$\beta = 1100.$$

$$\mathbf{k}_\alpha = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & -0.0058216 & -0.0458333 & 0. & 0. & 0.0126528 & 0. & 0. & -0.0126528 \\ 0. & 0. & -0.0458333 & -0.360845 & 0. & 0. & 0.0996155 & 0. & 0. & -0.0996155 \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0.0126528 & 0.0996155 & 0. & 0. & -0.0275 & 0. & 0. & 0.0275 \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & -0.0126528 & -0.0996155 & 0. & 0. & 0.0275 & 0. & 0. & -0.0275 \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_\beta = \begin{pmatrix} 0. \\ 0. \\ -1.0331 \\ -8.13357 \\ 0. \\ 0. \\ 2.24537 \\ 0. \\ 0. \\ 0. \\ -2.24537 \\ 0. \end{pmatrix}$$

Adding contributions from all Gauss points

$$\mathbf{k}_\alpha = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & -0.55 & -0.275 & 0. & 0. & 0.336805 & 0. & 0.0869626 & 0. \\ 0. & 0. & -0.275 & -0.55 & 0. & 0. & 0.336805 & 0. & -0.0869626 & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0.336805 & 0.336805 & 0. & 0. & -0.33 & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0.0869626 & -0.0869626 & 0. & 0. & 0. & 0. & -0.055 & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_\beta = \begin{pmatrix} 0. \\ 0. \\ -16.5 \\ -16.5 \\ 0. \\ 0. \\ 13.4722 \\ 0. \\ 0. \\ 0. \\ 0. \\ 0. \end{pmatrix}$$

Specified NBC values for side 4: $\alpha = 0$ $\beta = 8000$

Interpolation functions for mapping: $\left\{ \frac{a+1}{2}, 0, 0, \frac{1-a}{2} \right\}$

Interpolation functions for solution: $\left\{ \frac{a+1}{2}, 0, 0, \frac{1-a}{2}, 0, 0, 0, \frac{\frac{3a^2}{2} - \frac{3}{2}}{\sqrt{6}}, 0, 0, 0, \frac{\frac{5a}{2} - \frac{5a^3}{2}}{\sqrt{10}} \right\}$

$x(a) = 0$ $y(a) = 0.015 - 0.015 a$

$J_c = 0.015$

Value in mapped coordinate: $\alpha(a) = 0$ $\beta(a) = 8000$

Gauss point = -0.774597 $\text{Weight} = 0.555556$

$$\mathbf{N}_c^T = \{0.112702, 0., 0., 0.887298, 0., 0., 0., -0.244949, 0., 0., 0., -0.244949\}$$

$$J_c = 0.015 \quad \alpha = 0. \quad \beta = 8000.$$

$$\mathbf{k}_\alpha = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix} \quad \mathbf{r}_\beta = \begin{pmatrix} -7.51344 \\ 0. \\ 0. \\ -59.1532 \\ 0. \\ 0. \\ 0. \\ 16.3299 \\ 0. \\ 0. \\ 0. \\ 16.3299 \end{pmatrix}$$

$$\text{Gauss point} = 0. \quad \text{Weight} = 0.888889$$

$$\mathbf{N}_c^T = \{0.5, 0., 0., 0.5, 0., 0., 0., -0.612372, 0., 0., 0., 0.\}$$

$$J_c = 0.015 \quad \alpha = 0. \quad \beta = 8000.$$

$$\mathbf{k}_\alpha = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix} \quad \mathbf{r}_\beta = \begin{pmatrix} -53.3333 \\ 0. \\ 0. \\ -53.3333 \\ 0. \\ 0. \\ 0. \\ 65.3197 \\ 0. \\ 0. \\ 0. \\ 0. \end{pmatrix}$$

$$\text{Gauss point} = 0.774597 \quad \text{Weight} = 0.555556$$

$$\mathbf{N}_c^T = \{0.887298, 0., 0., 0.112702, 0., 0., 0., -0.244949, 0., 0., 0., 0.244949\}$$

$$J_c = 0.015 \quad \alpha = 0. \quad \beta = 8000.$$

Adding contributions from all Gauss points

$$\begin{aligned} \mathbf{k}_\alpha &= \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix} \\ \mathbf{r}_\beta &= \begin{pmatrix} -120. \\ 0. \\ 0. \\ -120. \\ 0. \\ 0. \\ 0. \\ 97.9796 \\ 0. \\ 0. \\ 0. \\ 0. \\ 0. \end{pmatrix} \end{aligned}$$

$$\begin{pmatrix}
 22.5794 & -0.15873 & -11.0913 & -11.3294 & -9.57439 & 1.04492 & 9.57439 & -7.41165 & 2.447 \\
 -0.15873 & 45.0425 & -22.955 & -22.3413 & -17.5936 & -1.92144 & 17.5936 & 14.8233 & -0.269797 \\
 -11.0913 & -22.955 & 33.2425 & -0.43373 & 8.40797 & -6.92734 & -17.2568 & 3.54787 & -2.447 \\
 -11.3294 & -22.3413 & -0.43373 & 33.2794 & 18.76 & 8.14067 & -9.23759 & -10.9595 & 2.36004 \\
 -9.57439 & -17.5936 & 8.40797 & 18.76 & 35.6548 & 6.13095 & -1.90476 & -8.69048 & 0.368856 \\
 1.04492 & -1.92144 & -6.92734 & 8.14067 & 6.13095 & 58.2874 & 1.36905 & 15.7738 & 0.461069 \\
 9.57439 & 17.5936 & -17.2568 & -9.23759 & -1.90476 & 1.36905 & 35.3248 & 1.19048 & -3.27359 \\
 -7.41165 & 14.8233 & 3.54787 & -10.9595 & -8.69048 & 15.7738 & 1.19048 & 47.2381 & -0.230535 \\
 2.447 & -4.894 & 4.894 & -2.447 & -3.27359 & -0.461069 & -5.44062 & 0.230535 & -2.24387 \\
 -0.269797 & 0.496114 & -0.496114 & 0.269797 & -1.58301 & -3.16601 & 1.58301 & 1.58301 & -2.24387 \\
 -2.447 & 4.894 & -4.80704 & 2.36004 & 0.368856 & 0.461069 & -3.27359 & -0.230535 & -2.24387 \\
 1.91368 & -3.82736 & 3.82736 & -1.91368 & 2.24387 & -4.22647 & -2.24387 & -2.24387 & -4.22647
 \end{pmatrix}$$

Global equations after assembling all elements

47.7183	19.8611	-5.97222	-39.1865	-11.0913	-11.3294	-29.6466	-4.13108
19.8611	70.1389	-39.0278	-50.9722	0	0	-43.8381	31.299
-5.97222	-39.0278	43.7556	0.419444	0	0	14.1915	-16.6701
-39.1865	-50.9722	0.419444	133.798	-22.955	-22.3413	59.2932	-37.6658
-11.0913	0	0	-22.955	33.2425	-0.43373	0	8.40797
-11.3294	0	0	-22.3413	-0.43373	33.2794	0	18.76
-29.6466	-43.8381	14.1915	59.2932	0	0	58.5952	-34.7619
-4.13108	31.299	-16.6701	-37.6658	8.40797	18.76	-34.7619	132.738
-7.41165	0	0	14.8233	3.54787	-10.9595	0	-8.69048
-5.44331	5.44331	-20.0722	20.0722	0	0	4.7619	37.9167
4.17968	32.5627	-28.0462	-8.02256	0	0	-13.6905	24.5238
1.04492	0	0	-1.92144	-6.92734	8.14067	0	6.13095
9.57439	0	0	17.5936	-17.2568	-9.23759	0	-1.90476
7.65472	-7.65472	15.3094	-15.3094	0	0	-8.97549	8.97549
3.76462	-1.31762	2.63523	-7.52923	4.894	-2.447	0.922139	-18.4428
1.91368	0	0	-3.82736	3.82736	-1.91368	0	2.24387
-1.31762	1.31762	-2.63523	2.63523	0	0	-0.922139	3.55023
-1.07919	1.07919	-2.07142	2.07142	0	0	6.33202	-6.33202
-0.269797	0	0	0.496114	-0.496114	0.269797	0	-1.58301
-2.447	0	0	4.894	-4.80704	2.36004	0	0.368856

Essential boundary conditions

On element 1, side 1, specified value = 110

$$\{T_1, T_2, \delta_1^{(1,2)}, \delta_2^{(1,2)}\} = \{110, 110, 0, 0\}$$

Known values from EBC

$$\{T_1 = 110, T_2 = 110, \delta_1^{(1,2)} = 0, \delta_2^{(1,2)} = 0\}$$

Global equations after EBC

$$\begin{pmatrix}
 43.7556 & 0.419444 & 0 & 0 & -16.6701 & 0 & -20.0722 & -28.0462 & 0 \\
 0.419444 & 133.798 & -22.955 & -22.3413 & -37.6658 & 14.8233 & 20.0722 & -8.02256 & -1 \\
 0 & -22.955 & 33.2425 & -0.43373 & 8.40797 & 3.54787 & 0 & 0 & -6 \\
 0 & -22.3413 & -0.43373 & 33.2794 & 18.76 & -10.9595 & 0 & 0 & 8 \\
 -16.6701 & -37.6658 & 8.40797 & 18.76 & 132.738 & -8.69048 & 37.9167 & 24.5238 & 6 \\
 0 & 14.8233 & 3.54787 & -10.9595 & -8.69048 & 47.2381 & 0 & 0 & 15 \\
 -20.0722 & 20.0722 & 0 & 0 & 37.9167 & 0 & 97.0833 & 5.47619 & 0 \\
 -28.0462 & -8.02256 & 0 & 0 & 24.5238 & 0 & 5.47619 & 49.551 & 0 \\
 0 & -1.92144 & -6.92734 & 8.14067 & 6.13095 & 15.7738 & 0 & 0 & 58 \\
 0 & 17.5936 & -17.2568 & -9.23759 & -1.90476 & 1.19048 & 0 & 0 & 1 \\
 2.63523 & -7.52923 & 4.894 & -2.447 & -18.4428 & 0.230535 & -19.6877 & -1.84428 & -0 \\
 0 & -3.82736 & 3.82736 & -1.91368 & 2.24387 & -2.24387 & 0 & 0 & -4 \\
 -2.63523 & 2.63523 & 0 & 0 & 3.55023 & 0 & -15.1692 & 1.84428 & 0 \\
 -2.07142 & 2.07142 & 0 & 0 & -6.33202 & 0 & 6.33202 & -12.664 & 0 \\
 0 & 0.496114 & -0.496114 & 0.269797 & -1.58301 & 1.58301 & 0 & 0 & -3 \\
 0 & 4.894 & -4.80704 & 2.36004 & 0.368856 & -0.230535 & 0 & 0 & 0
 \end{pmatrix}$$

Solving the final system of global equations we get

$$\begin{aligned}
 \{T_3 = 125.645, T_4 = 138.336, T_5 = 161.689, T_6 = 159.31, \delta_1^{[1,4]} = -10.8975, \delta_1^{[1,6]} = -15.6733, \\
 \delta_1^{[2,3]} = -6.12049, \delta_1^{[3,4]} = 6.06916, \delta_1^{[4,5]} = -5.59893, \delta_1^{[5,6]} = 3.005, \delta_2^{[1,4]} = -1.5215, \\
 \delta_2^{[1,6]} = -0.51993, \delta_2^{[2,3]} = 0.300845, \delta_2^{[3,4]} = 0.807652, \delta_2^{[4,5]} = -0.0985235, \delta_2^{[5,6]} = 3.19562\}
 \end{aligned}$$

Solution for element 1

DOF values for the element

$$\begin{aligned}
 \{T_1 = 110, T_2 = 110, T_3 = 125.645, T_4 = 138.336, \delta_1^{[1,2]} = 0, \delta_1^{[2,3]} = -6.12049, \\
 \delta_1^{[3,4]} = 6.06916, \delta_1^{[1,4]} = -10.8975, \delta_2^{[1,2]} = 0, \delta_2^{[2,3]} = 0.300845, \delta_2^{[3,4]} = 0.807652, \delta_2^{[1,4]} = -1.5215\}
 \end{aligned}$$

$$\mathbf{d}^T = (110 \quad 110 \quad 125.645 \quad 138.336 \quad 0 \quad -6.12049 \quad 6.06916 \quad -10.8975 \quad 0 \quad 0.300845 \quad 0.807652 \quad -1.5215)$$

Mapping

$$x(s,t) = -0.0075 \, t \, s + 0.0225 \, s + 0.0075 \, t + 0.0375$$

$$y(s,t) = 0.0075 \, t + 0.0075$$

$$\mathbf{J} = \begin{pmatrix} 0.0225 - 0.0075 \, t & 0.0075 - 0.0075 \, s \\ 0 & 0.0075 \end{pmatrix}$$

Element solution at $\{s \rightarrow 0, t \rightarrow 0\}$

Location: $\{0.0375, 0.0075\}$

$$\mathbf{N}^T = (0.25 \quad 0.25 \quad 0.25 \quad 0.25 \quad -0.306186 \quad -0.306186 \quad -0.306186 \quad -0.306186 \quad 0. \quad 0. \quad 0. \quad 0.)$$

$$\partial \mathbf{N}^T / \partial s =$$

$$(-0.25 \quad 0.25 \quad 0.25 \quad -0.25 \quad 0. \quad -0.306186 \quad 0. \quad 0.306186 \quad -0.395285 \quad 0. \quad -0.395285 \quad 0.)$$

$$\partial \mathbf{N}^T / \partial t = (-0.25 \quad -0.25 \quad 0.25 \quad 0.25 \quad 0.306186 \quad 0. \quad -0.306186 \quad 0. \quad 0. \quad -0.395285 \quad 0. \quad -0.395285)$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 44.4444 & 0. \\ -44.4444 & 133.333 \end{pmatrix}$$

$$\mathbf{B}_x^T = \partial \mathbf{N}^T / \partial x =$$

$$(-11.1111 \quad 11.1111 \quad 11.1111 \quad -11.1111 \quad 0. \quad -13.6083 \quad 0. \quad 13.6083 \quad -17.5682 \quad 0. \quad -17.5682 \quad 0.)$$

$$\mathbf{B}_y^T = \partial \mathbf{N}^T / \partial y = (-22.2222 \quad -44.4444 \quad 22.2222 \quad 44.4444 \quad 40.8248 \quad 13.6083 \quad -40.8248 \quad -13.6083 \quad 1$$

$$\mathbf{T} = \mathbf{N}^T \mathbf{d} = 124.347$$

$$\partial \mathbf{T} / \partial x = \mathbf{B}_x^T \mathbf{d} = -220.205$$

$$\partial \mathbf{T} / \partial y = \mathbf{B}_y^T \mathbf{d} = 1502.78$$

	x	y	\mathbf{T}	$\partial \mathbf{T} / \partial x$	$\partial \mathbf{T} / \partial y$
1	0.0375	0.0075	124.347	-220.205	1502.78

Solution for element 2

DOF values for the element

$$\{T_1 = 110, T_4 = 138.336, T_5 = 161.689, T_6 = 159.31, \delta_1^{[1,4]} = -10.8975, \delta_1^{[4,5]} = -5.59893, \delta_1^{[5,6]} = 3.005, \\ \delta_1^{[1,6]} = -15.6733, \delta_2^{[1,4]} = -1.5215, \delta_2^{[4,5]} = -0.0985235, \delta_2^{[5,6]} = 3.19562, \delta_2^{[1,6]} = -0.51993\}$$

$$\mathbf{d}^T = (110 \quad 138.336 \quad 161.689 \quad 159.31 \quad -10.8975 \quad -5.59893 \quad 3.005 \quad -15.6733 \quad -1.5215 \quad -0.0985235 \quad 3.19562 \quad -0.51993)$$

Mapping

$$x(s, t) = 0.015s + 0.015$$

$$y(s, t) = -0.00375ts + 0.00375s + 0.01125t + 0.01875$$

$$\mathbf{J} = \begin{pmatrix} 0.015 & 0 \\ 0.00375 - 0.00375t & 0.01125 - 0.00375s \end{pmatrix}$$

Element solution at $\{s \rightarrow 0, t \rightarrow 0\}$

Location: $\{0.015, 0.01875\}$

$$\mathbf{N}^T = (0.25 \quad 0.25 \quad 0.25 \quad 0.25 \quad -0.306186 \quad -0.306186 \quad -0.306186 \quad -0.306186 \quad 0. \quad 0. \quad 0. \quad 0.)$$

$$\begin{aligned}
\partial \mathbf{N}^T / \partial s &= \\
(-0.25 \quad 0.25 \quad 0.25 \quad -0.25 \quad 0. \quad -0.306186 \quad 0. \quad 0.306186 \quad -0.395285 \quad 0. \quad -0.395285 \quad 0.) \\
\partial \mathbf{N}^T / \partial t &= (-0.25 \quad -0.25 \quad 0.25 \quad 0.25 \quad 0.306186 \quad 0. \quad -0.306186 \quad 0. \quad 0. \quad -0.395285 \quad 0. \quad -0.395285) \\
\mathbf{J}^{-T} &= \begin{pmatrix} 66.6667 & -22.2222 \\ 0. & 88.8889 \end{pmatrix} \\
\mathbf{B}_x^T = \partial \mathbf{N}^T / \partial x &= (-11.1111 \quad 22.2222 \quad 11.1111 \quad -22.2222 \quad -6.80414 \quad -20.4124 \quad 6.80414 \quad 20.4124 \quad - \\
\mathbf{B}_y^T = \partial \mathbf{N}^T / \partial y &= \\
(-22.2222 \quad -22.2222 \quad 22.2222 \quad 22.2222 \quad 27.2166 \quad 0. \quad -27.2166 \quad 0. \quad 0. \quad -35.1364 \quad 0. \quad -35.1364) \\
T = \mathbf{N}^T \mathbf{d} &= 151.263 \\
\partial T / \partial x = \mathbf{B}_x^T \mathbf{d} &= -52.3684 \\
\partial T / \partial y = \mathbf{B}_y^T \mathbf{d} &= 1258.08
\end{aligned}$$

	x	y	T	$\partial T / \partial x$	$\partial T / \partial y$
1	0.015	0.01875	151.263	-52.3684	1258.08

Nodal solution summary

dof	x	y	Value
T ₁	0	0	110
T ₂	0.06	0	110
T ₃	0.06	0.015	125.645
T ₄	0.03	0.015	138.336
T ₅	0.03	0.03	161.689
T ₆	0	0.03	159.31

Element solution summary

	x	y	T	$\partial T / \partial x$	$\partial T / \partial y$
1	0.0375	0.0075	124.347	-220.205	1502.78
2	0.015	0.01875	151.263	-52.3684	1258.08

With $n = 4$ the following finite element solution is obtained.

Interpolation functions for mapping: $\left\{ \frac{1}{4} (1-s)(1-t), \frac{1}{4} (s+1)(1-t), \frac{1}{4} (s+1)(t+1), \frac{1}{4} (1-s)(t+1) \right\}$

Interpolation functions for assumed solution: $N^T =$

$$\begin{aligned}
 & \left\{ \frac{1}{4} (1-s)(1-t), \frac{1}{4} (s+1)(1-t), \frac{1}{4} (s+1)(t+1), \frac{1}{4} (1-s)(t+1), \frac{\left(\frac{3s^2}{2} - \frac{3}{2}\right)(1-t)}{2\sqrt{6}}, \right. \\
 & \frac{(s+1)\left(\frac{3t^2}{2} - \frac{3}{2}\right)}{2\sqrt{6}}, \frac{\left(\frac{3s^2}{2} - \frac{3}{2}\right)(t+1)}{2\sqrt{6}}, \frac{(1-s)\left(\frac{3t^2}{2} - \frac{3}{2}\right)}{2\sqrt{6}}, \frac{\left(\frac{5s^3}{2} - \frac{5s}{2}\right)(1-t)}{2\sqrt{10}}, \frac{(s+1)\left(\frac{5t^3}{2} - \frac{5t}{2}\right)}{2\sqrt{10}}, \\
 & \frac{\left(\frac{5s^3}{2} - \frac{5s}{2}\right)(t+1)}{2\sqrt{10}}, \frac{(1-s)\left(\frac{5t^3}{2} - \frac{5t}{2}\right)}{2\sqrt{10}}, \frac{\left(\frac{35s^4}{8} - \frac{21s^2}{4} + \frac{7}{8}\right)(1-t)}{2\sqrt{14}}, \frac{(s+1)\left(\frac{35t^4}{8} - \frac{21t^2}{4} + \frac{7}{8}\right)}{2\sqrt{14}}, \\
 & \left. \frac{\left(\frac{35s^4}{8} - \frac{21s^2}{4} + \frac{7}{8}\right)(t+1)}{2\sqrt{14}}, \frac{(1-s)\left(\frac{35t^4}{8} - \frac{21t^2}{4} + \frac{7}{8}\right)}{2\sqrt{14}}, \frac{1}{6} \left(\frac{3s^2}{2} - \frac{3}{2} \right) \left(\frac{3t^2}{2} - \frac{3}{2} \right) \right\} \\
 \partial N^T / \partial s = & \left\{ \frac{t-1}{4}, \frac{1-t}{4}, \frac{t+1}{4}, \frac{1}{4} (-t-1), \frac{1}{2} \sqrt{\frac{3}{2}} s (1-t), \frac{\frac{3t^2}{2} - \frac{3}{2}}{2\sqrt{6}}, \frac{1}{2} \sqrt{\frac{3}{2}} s (t+1), -\frac{\frac{3t^2}{2} - \frac{3}{2}}{2\sqrt{6}}, \right. \\
 & \frac{\left(\frac{15s^2}{2} - \frac{5}{2}\right)(1-t)}{2\sqrt{10}}, \frac{\frac{5t^3}{2} - \frac{5t}{2}}{2\sqrt{10}}, \frac{\left(\frac{15s^2}{2} - \frac{5}{2}\right)(t+1)}{2\sqrt{10}}, -\frac{\frac{5t^3}{2} - \frac{5t}{2}}{2\sqrt{10}}, \frac{\left(\frac{35s^3}{2} - \frac{21s}{2}\right)(1-t)}{2\sqrt{14}}, \\
 & \frac{\frac{35t^4}{8} - \frac{21t^2}{4} + \frac{7}{8}}{2\sqrt{14}}, \frac{\left(\frac{35s^3}{2} - \frac{21s}{2}\right)(t+1)}{2\sqrt{14}}, -\frac{\frac{35t^4}{8} - \frac{21t^2}{4} + \frac{7}{8}}{2\sqrt{14}}, \frac{1}{2} s \left(\frac{3t^2}{2} - \frac{3}{2} \right) \Big\} \\
 \partial N^T / \partial t = & \left\{ \frac{s-1}{4}, \frac{1}{4} (-s-1), \frac{s+1}{4}, \frac{1-s}{4}, -\frac{\frac{3s^2}{2} - \frac{3}{2}}{2\sqrt{6}}, \frac{1}{2} \sqrt{\frac{3}{2}} (s+1)t, \frac{\frac{3s^2}{2} - \frac{3}{2}}{2\sqrt{6}}, \frac{1}{2} \sqrt{\frac{3}{2}} (1-s)t, \right. \\
 & -\frac{\frac{5s^3}{2} - \frac{5s}{2}}{2\sqrt{10}}, \frac{(s+1)\left(\frac{15t^2}{2} - \frac{5}{2}\right)}{2\sqrt{10}}, \frac{\frac{5s^3}{2} - \frac{5s}{2}}{2\sqrt{10}}, \frac{(1-s)\left(\frac{15t^2}{2} - \frac{5}{2}\right)}{2\sqrt{10}}, -\frac{\frac{35s^4}{8} - \frac{21s^2}{4} + \frac{7}{8}}{2\sqrt{14}}, \\
 & \left. \frac{(s+1)\left(\frac{35t^3}{2} - \frac{21t}{2}\right)}{2\sqrt{14}}, \frac{\frac{35s^4}{8} - \frac{21s^2}{4} + \frac{7}{8}}{2\sqrt{14}}, \frac{(1-s)\left(\frac{35t^3}{2} - \frac{21t}{2}\right)}{2\sqrt{14}}, \frac{1}{2} \left(\frac{3s^2}{2} - \frac{3}{2} \right) t \right\}
 \end{aligned}$$

Use 4×4 Gauss quadrature for integration.

Global equations at start of the element assembly process

Equations for element 1

$$x(s,t) = -0.0075 ts + 0.0225 s + 0.0075 t + 0.0375$$

$$y(s,t) = 0.0075 t + 0.0075$$

$$\mathbf{J} = \begin{pmatrix} 0.0225 - 0.0075 t & 0.0075 - 0.0075 s \\ 0 & 0.0075 \end{pmatrix}$$

$$\det \mathbf{J} = 0.00016875 - 0.00005625 t$$

Given element data

$$k_x = 45 \quad k_y = 45 \quad p = 0 \quad q = 5000000$$

Element data in mapped coordinates

$$k_x = 45 \quad k_y = 45 \quad p = 0 \quad q = 5000000$$

$$\text{Gauss point} = \{s \rightarrow -0.861136, t \rightarrow -0.861136\} \quad \text{Weight} = 0.121003$$

$$\mathbf{N}^T = \{0.865957, 0.0646111, 0.00482078, 0.0646111, -0.147276, -0.0109886, -0.0109886, -0.147276, 0.16373, 0.0122162, 0.0122162, 0.16373, -0.15229, -0.0113627, -0.0113627, -0.15229, 0.0250475\}$$

$$\partial \mathbf{N}^T / \partial s = (-0.465284 \quad 0.465284 \quad 0.0347159 \quad -0.0347159 \quad -0.981444 \quad -0.0791321 \quad -0.0732278 \quad 0.0732278 \quad 0.981444 \quad 0.0791321 \quad 0.0732278 \quad -0.0732278 \quad -0.981444 \quad 0.0791321 \quad 0.0732278 \quad -0.0732278)$$

$$\partial \mathbf{N}^T / \partial t = (-0.465284 \quad -0.0347159 \quad 0.0347159 \quad 0.465284 \quad 0.0791321 \quad -0.0732278 \quad -0.0791321 \quad -0.465284 \quad -0.0791321 \quad 0.0732278 \quad 0.0791321 \quad -0.0732278 \quad -0.465284 \quad 0.0347159 \quad -0.0347159 \quad 0.465284)$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 34.5321 & 0. \\ -64.269 & 133.333 \end{pmatrix} \quad \det \mathbf{J} = 0.000217189$$

$$\mathbf{B}^T = \begin{pmatrix} -16.0673 & 16.0673 & 1.19882 & -1.19882 & -33.8914 & -2.7326 & -2.52871 & 2.7326 & 31.19882 \\ -32.1345 & -34.5321 & 2.39763 & 64.269 & 73.6274 & -4.67797 & -5.84466 & -135.945 & -69.1345 \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$k_k = \begin{pmatrix} 1.52651 & 1.00702 & -0.113897 & -2.41964 & -2.15408 & 0.229701 & 0.270164 \\ 1.00702 & 1.71554 & -0.0751364 & -2.64743 & -3.65082 & 0.139118 & 0.190638 \\ -0.113897 & -0.0751364 & 0.00849808 & 0.180535 & 0.160721 & -0.0171385 & -0.0201576 \\ -2.41964 & -2.64743 & 0.180535 & 4.88653 & 5.64418 & -0.35168 & -0.440644 \\ -2.15408 & -3.65082 & 0.160721 & 5.64418 & 7.76939 & -0.297803 & -0.407562 \\ 0.229701 & 0.139118 & -0.0171385 & -0.35168 & -0.297803 & 0.0347106 & 0.0405061 \\ 0.270164 & 0.190638 & -0.0201576 & -0.440644 & -0.407562 & 0.0405061 & 0.0479061 \\ 5.1144 & 5.60371 & -0.381597 & -10.3365 & -11.9467 & 0.743254 & 0.931481 \\ 2.05511 & 3.43491 & -0.153337 & -5.33669 & -7.31024 & 0.284689 & 0.388201 \\ -0.183481 & -0.0774147 & 0.0136899 & 0.247206 & 0.166375 & -0.0281243 & -0.0319381 \\ -0.325688 & -0.258479 & 0.0243003 & 0.559866 & 0.552118 & -0.0484924 & -0.0581181 \\ -4.72238 & -5.19448 & 0.352347 & 9.56451 & 11.0741 & -0.686044 & -0.860331 \\ -1.36231 & -2.18617 & 0.101645 & 3.44684 & 4.6533 & -0.189789 & -0.256301 \\ 0.0544176 & -0.0529113 & -0.00406023 & 0.00255384 & 0.11159 & 0.00923716 & 0.008581 \\ 0.343912 & 0.315685 & -0.02566 & -0.633936 & -0.673677 & 0.0507011 & 0.0619111 \\ 2.83447 & 3.15734 & -0.211486 & -5.78032 & -6.73068 & 0.411311 & 0.516881 \\ -0.547623 & -0.361261 & 0.0408594 & 0.868025 & 0.772757 & -0.0824032 & -0.096911 \end{pmatrix}$$

$$k_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$r_q^T = (113.789 \quad 8.49006 \quad 0.633463 \quad 8.49006 \quad -19.3524 \quad -1.44393 \quad -1.44393 \quad -19.3524 \quad 21.5145 \quad 1)$$

Gauss point = {s → -0.861136, t → -0.339981} Weight = 0.226852

$$\mathbf{N}^T = \{0.623472, 0.0465187, 0.0229132, 0.307096, -0.106035, -0.0376036, -0.0522287, -0.503986, \\ 0.117882, 0.0165047, 0.0580638, 0.221207, -0.109646, 0.00606089, -0.0540071, 0.0812318, 0.0857143\}$$

$$\partial \mathbf{N}^T / \partial s = (-0.334995 \quad 0.334995 \quad 0.165005 \quad -0.165005 \quad -0.70662 \quad -0.270795 \quad -0.348052 \quad 0.270795)$$

$$\partial \mathbf{N}^T / \partial t = (-0.465284 \quad -0.0347159 \quad 0.0347159 \quad 0.465284 \quad 0.0791321 \quad -0.0289107 \quad -0.0791321 \quad -0.$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 39.9204 & 0. \\ -74.2973 & 133.333 \end{pmatrix} \quad \det \mathbf{J} = 0.000187874$$

$$\mathbf{B}^T = \begin{pmatrix} -13.3731 & 13.3731 & 6.58705 & -6.58705 & -28.2086 & -10.8102 & -13.8944 & 10.8102 & 25. \\ -37.1486 & -29.518 & -7.63061 & 74.2973 & 63.0509 & 16.2646 & 15.3084 & -71.7832 & -59. \end{pmatrix}$$

$$\mathbf{k}_k = \begin{matrix} k_x = 45. & k_y = 45. & p = 0. & q = 5. \times 10^6 \\ \left(\begin{array}{ccccccc} 2.98971 & 1.76006 & 0.37471 & -5.12449 & -3.76867 & -0.881534 & -0.734306 \\ 1.76006 & 2.01407 & 0.60093 & -4.37506 & -4.29294 & -1.19803 & -1.223 \\ 0.37471 & 0.60093 & 0.194886 & -1.17053 & -1.27909 & -0.374593 & -0.399562 \\ -5.12449 & -4.37506 & -1.17053 & 10.6701 & 9.34069 & 2.45416 & 2.35687 & - \\ -3.76867 & -4.29294 & -1.27909 & 9.34069 & 9.15048 & 2.55162 & 2.60284 & - \\ -0.881534 & -1.19803 & -0.374593 & 2.45416 & 2.55162 & 0.731475 & 0.76559 & - \\ -0.734306 & -1.223 & -0.399562 & 2.35687 & 2.60284 & 0.76559 & 0.819701 & - \\ 4.83705 & 4.34106 & 1.18709 & -10.3652 & -9.26516 & -2.4633 & -2.3956 \\ 3.60525 & 4.05661 & 1.20411 & -8.86597 & -8.64726 & -2.40613 & -2.44941 \\ 0.848083 & 0.892271 & 0.259141 & -1.99949 & -1.90266 & -0.522964 & -0.526067 \\ 0.528461 & 1.00699 & 0.336883 & -1.87234 & -2.14223 & -0.639048 & -0.69247 \\ 4.05777 & 3.00589 & 0.74856 & -7.81222 & -6.42386 & -1.62494 & -1.49556 \\ -2.4082 & -2.61541 & -0.76764 & 5.79125 & 5.57612 & 1.54175 & 1.5599 & - \\ -0.321699 & -0.175422 & -0.0348883 & 0.53201 & 0.375896 & 0.0851577 & 0.0677213 & - \\ -0.0259925 & -0.366366 & -0.139796 & 0.532155 & 0.777425 & 0.251446 & 0.290245 & - \\ -6.99554 & -5.6388 & -1.46813 & 14.1025 & 12.0434 & 3.11851 & 2.9476 & - \\ 1.81275 & 2.48995 & 0.780552 & -5.08325 & -5.30297 & -1.52248 & -1.59564 \end{array} \right. \end{matrix}$$

$$\mathbf{k}_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_q^T = (132.86 \quad 9.91303 \quad 4.88274 \quad 65.4415 \quad -22.5959 \quad -8.01324 \quad -11.1298 \quad -107.398 \quad 25.1204 \quad 3.5$$

$$\text{Gauss point} = \{s \rightarrow -0.861136, t \rightarrow 0.339981\} \quad \text{Weight} = 0.226852$$

$$\mathbf{N}^T = \{0.307096, 0.0229132, 0.0465187, 0.623472, -0.0522287, -0.0376036, -0.106035, -0.503986, 0.0580638, \\ -0.0165047, 0.117882, -0.221207, -0.0540071, 0.00606089, -0.109646, 0.0812318, 0.0857143\}$$

$$\partial \mathbf{N}^T / \partial s = (-0.165005 \quad 0.165005 \quad 0.334995 \quad -0.334995 \quad -0.348052 \quad -0.270795 \quad -0.70662 \quad 0.270795)$$

$$\partial \mathbf{N}^T / \partial t = (-0.465284 \quad -0.0347159 \quad 0.0347159 \quad 0.465284 \quad 0.0791321 \quad 0.0289107 \quad -0.0791321 \quad 0.387$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 50.125 & 0. \\ -93.2894 & 133.333 \end{pmatrix} \quad \det \mathbf{J} = 0.000149626$$

$$\mathbf{B}^T = \begin{pmatrix} -8.27086 & 8.27086 & 16.7916 & -16.7916 & -17.4461 & -13.5736 & -35.4193 & 13.5736 & 16 \\ -46.6447 & -20.022 & -26.6227 & 93.2894 & 43.0205 & 29.1171 & 55.3692 & 26.4016 & -41 \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$k_k = \begin{pmatrix} 3.42776 & 1.32201 & 1.68465 & -6.43442 & -2.84466 & -1.90301 & -3.49741 & -2.0525 \\ 1.32201 & 0.716804 & 1.02631 & -3.06513 & -1.53606 & -1.06194 & -2.14077 & -0.63594 \\ 1.68465 & 1.02631 & 1.51327 & -4.22423 & -2.19686 & -1.53216 & -3.15999 & -0.72546 \\ -6.43442 & -3.06513 & -4.22423 & 13.7238 & 6.57759 & 4.49712 & 8.79818 & 3.41391 \\ -2.84466 & -1.53606 & -2.19686 & 6.57759 & 3.29181 & 2.27501 & 4.58221 & 1.37317 \\ -1.90301 & -1.06194 & -1.53216 & 4.49712 & 2.27501 & 1.57638 & 3.19685 & 0.89277 \\ -3.49741 & -2.14077 & -3.15999 & 8.79818 & 4.58221 & 3.19685 & 6.59894 & 1.49852 \\ -2.0525 & -0.635942 & -0.725469 & 3.41391 & 1.37317 & 0.892777 & 1.49852 & 1.34611 \\ 2.75702 & 1.47261 & 2.09983 & -6.32945 & -3.15618 & -2.17936 & -4.37931 & -1.34291 \\ -0.374094 & -0.268148 & -0.409275 & 1.05152 & 0.573201 & 0.404021 & 0.855718 & 0.13082 \\ 3.06498 & 1.90271 & 2.81774 & -7.78543 & -4.07213 & -2.84379 & -5.88493 & -1.29322 \\ 5.27995 & 2.37396 & 3.20932 & -10.8632 & -5.09788 & -3.46641 & -6.67918 & -2.90762 \\ -1.90871 & -0.989587 & -1.39929 & 4.29759 & 2.1216 & 1.46138 & 2.91736 & 0.95221 \\ 0.770509 & 0.370239 & 0.511659 & -1.65241 & -0.794432 & -0.543587 & -1.06579 & -0.40641 \\ -1.51966 & -0.998018 & -1.49649 & 4.01417 & 2.13489 & 1.49658 & 3.12688 & 0.60009 \\ 6.54673 & 2.77065 & 3.6647 & -12.9821 & -5.95427 & -4.02406 & -7.62008 & -3.73522 \\ 4.06082 & 2.26005 & 3.25852 & -9.5794 & -4.84187 & -3.35429 & -6.79871 & -1.90962 \end{pmatrix}$$

$$k_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$r_q^T = (52.1188 \quad 3.8887 \quad 7.89491 \quad 105.812 \quad -8.86397 \quad -6.38189 \quad -17.9958 \quad -85.5339 \quad 9.85428 \quad -2.8)$$

Gauss point = {s → -0.861136, t → 0.861136}

Weight = 0.121003

$$\mathbf{N}^T = \{0.0646111, 0.00482078, 0.0646111, 0.865957, -0.0109886, -0.0109886, -0.147276, -0.147276, 0.0122162, -0.0122162, 0.16373, -0.16373, -0.0113627, -0.0113627, -0.15229, -0.15229, 0.0250475\}$$

$$\partial \mathbf{N}^T / \partial s = (-0.0347159 \quad 0.0347159 \quad 0.465284 \quad -0.465284 \quad -0.0732278 \quad -0.0791321 \quad -0.981444 \quad 0.0791321 \quad 0.981444 \quad -0.0732278 \quad -0.0347159 \quad 0.0347159 \quad -0.465284 \quad 0.465284 \quad -0.0732278 \quad -0.0791321 \quad -0.981444 \quad 0.0791321 \quad 0.981444 \quad -0.0732278)$$

$$\partial \mathbf{N}^T / \partial t = (-0.465284 \quad -0.0347159 \quad 0.0347159 \quad 0.465284 \quad 0.0791321 \quad 0.0732278 \quad -0.0791321 \quad 0.981444 \quad -0.981444 \quad -0.0732278 \quad -0.0347159 \quad -0.465284 \quad 0.0791321 \quad 0.0732278 \quad -0.0791321 \quad -0.981444 \quad 0.981444 \quad -0.0732278 \quad -0.0347159 \quad -0.465284)$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 62.3384 & 0. \\ -116.02 & 133.333 \end{pmatrix} \quad \det \mathbf{J} = 0.000120311$$

$$\mathbf{B}^T = \begin{pmatrix} -2.16413 & 2.16413 & 29.0051 & -29.0051 & -4.56491 & -4.93297 & -61.1817 & 4.93297 \\ -58.0101 & -8.65654 & -49.3536 & 116.02 & 19.0469 & 18.9446 & 103.316 & 121.678 & -1 \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$\mathbf{k}_k = \begin{pmatrix} 2.20763 & 0.325906 & 1.83446 & -4.368 & -0.717366 & -0.71296 & -3.8396 & -4.631 \\ 0.325906 & 0.0521593 & 0.321005 & -0.699071 & -0.114486 & -0.114428 & -0.672646 & -0.683 \\ 1.83446 & 0.321005 & 2.14684 & -4.30231 & -0.702564 & -0.706252 & -4.50298 & -3.840 \\ -4.368 & -0.699071 & -4.30231 & 9.36938 & 1.53442 & 1.53364 & 9.01522 & 9.154 \\ -0.717366 & -0.114486 & -0.702564 & 1.53442 & 0.251314 & 0.251139 & 1.47213 & 1.503 \\ -0.71296 & -0.114428 & -0.706252 & 1.53364 & 0.251139 & 0.25106 & 1.47996 & 1.494 \\ -3.8396 & -0.672646 & -4.50298 & 9.01522 & 1.47213 & 1.47996 & 9.44505 & 8.037 \\ -4.63114 & -0.683042 & -3.84037 & 9.15455 & 1.50352 & 1.49419 & 8.03792 & 9.715 \\ 0.736217 & 0.116689 & 0.711037 & -1.56394 & -0.25621 & -0.255912 & -1.48975 & -1.543 \\ -0.720731 & -0.116486 & -0.724001 & 1.56122 & 0.255595 & 0.255634 & 1.51728 & 1.510 \\ 3.44706 & 0.605895 & 4.06763 & -8.12058 & -1.3259 & -1.33323 & -8.53216 & -7.215 \\ -4.18513 & -0.615589 & -3.44978 & 8.2505 & 1.35518 & 1.34649 & 7.22009 & 8.779 \\ -0.585658 & -0.0914152 & -0.548129 & 1.2252 & 0.200821 & 0.200378 & 1.1482 & 1.227 \\ -0.554132 & -0.0910011 & -0.57452 & 1.21965 & 0.199571 & 0.199811 & 1.20424 & 1.161 \\ -1.87772 & -0.334089 & -2.26586 & 4.47767 & 0.730827 & 0.73541 & 4.75335 & 3.930 \\ -2.33475 & -0.340092 & -1.88327 & 4.55812 & 0.748956 & 0.743625 & 3.94088 & 4.898 \\ 1.56698 & 0.250786 & 1.54342 & -3.36119 & -0.550459 & -0.550181 & -3.23414 & -3.284 \end{pmatrix}$$

$$\mathbf{k}_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_q^T = (4.70304 \quad 0.350905 \quad 4.70304 \quad 63.033 \quad -0.799858 \quad -0.799858 \quad -10.7202 \quad -10.7202 \quad 0.88922)$$

$$\text{Gauss point} = \{s \rightarrow -0.339981, t \rightarrow -0.861136\} \quad \text{Weight} = 0.226852$$

$$\mathbf{N}^T = \{0.623472, 0.307096, 0.0229132, 0.0465187, -0.503986, -0.0522287, -0.0376036, -0.106035, \\ 0.221207, 0.0580638, 0.0165047, 0.117882, 0.0812318, -0.0540071, 0.00606089, -0.109646, 0.0857143\}$$

$$\partial \mathbf{N}^T / \partial s = (-0.465284 \quad 0.465284 \quad 0.0347159 \quad -0.0347159 \quad -0.387479 \quad -0.0791321 \quad -0.0289107 \quad 0.0289107 \quad 0.0289107 \quad 0.0289107 \quad 0.0289107 \quad 0.0289107 \quad 0.0289107 \quad 0.0289107 \quad 0.0289107 \quad 0.0289107 \quad 0.0289107 \quad 0.0289107)$$

$$\partial \mathbf{N}^T / \partial t = (-0.334995 \quad -0.165005 \quad 0.165005 \quad 0.334995 \quad 0.270795 \quad -0.348052 \quad -0.270795 \quad -0.70662 \quad -0.70662 \quad -0.70662 \quad -0.70662 \quad -0.70662 \quad -0.70662 \quad -0.70662 \quad -0.70662 \quad -0.70662 \quad -0.70662 \quad -0.70662)$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 34.5321 & 0. \\ -46.2724 & 133.333 \end{pmatrix} \quad \det \mathbf{J} = 0.000217189$$

$$\mathbf{B}^T = \begin{pmatrix} -16.0673 & 16.0673 & 1.19882 & -1.19882 & -13.3805 & -2.7326 & -0.99835 & 2.7326 & -16.0673 \\ -23.1362 & -43.5305 & 20.3942 & 46.2724 & 54.0356 & -42.7453 & -34.7682 & -97.8777 & 6 \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$k_k = \begin{pmatrix} 1.75917 & 1.66058 & -1.08885 & -2.33089 & -2.29516 & 2.29001 & 1.81904 & 4.91717 \\ 1.66058 & 4.77362 & -1.9256 & -4.5086 & -5.6918 & 4.02813 & 3.32002 & 9.51717 \\ -1.08885 & -1.9256 & 0.925349 & 2.08911 & 2.40775 & -1.94007 & -1.57476 & -4.41717 \\ -2.33089 & -4.5086 & 2.08911 & 4.75038 & 5.5792 & -4.37807 & -3.5643 & -10.01717 \\ -2.29516 & -5.6918 & 2.40775 & 5.5792 & 6.87065 & -5.04 & -4.13577 & -11.81717 \\ 2.29001 & 4.02813 & -1.94007 & -4.37807 & -5.04 & 4.06762 & 3.30111 & 9.21717 \\ 1.81904 & 3.32002 & -1.57476 & -3.5643 & -4.13577 & 3.30111 & 2.68235 & 7.51717 \\ 4.9234 & 9.54381 & -4.41846 & -10.0488 & -11.8072 & 9.25952 & 7.53894 & 21.21717 \\ 0.263401 & -1.20789 & 0.244822 & 0.699663 & 1.25786 & -0.505041 & -0.455838 & -1.41717 \\ -2.08469 & -3.61049 & 1.75031 & 3.94487 & 4.52601 & -3.67003 & -2.97689 & -8.31717 \\ -0.853912 & -1.73372 & 0.788302 & 1.79933 & 2.1341 & -1.65164 & -1.34677 & -3.81717 \\ -4.53719 & -8.8485 & 4.08679 & 9.2989 & 10.9397 & -8.56422 & -6.97423 & -19.61717 \\ 1.11813 & 4.64453 & -1.69709 & -4.06557 & -5.40515 & 3.54493 & 2.95057 & 8.61717 \\ 1.19327 & 1.95508 & -0.970633 & -2.17772 & -2.46802 & 2.03578 & 1.64819 & 4.61717 \\ -0.237365 & -0.257026 & 0.15615 & 0.338242 & 0.345932 & -0.328183 & -0.261925 & -0.71717 \\ 2.70612 & 5.38157 & -2.46663 & -5.62107 & -6.63918 & 5.16854 & 4.21167 & 11.81717 \\ -3.83136 & -6.97506 & 3.31188 & 7.49454 & 8.69147 & -6.94264 & -5.64084 & -15.81717 \end{pmatrix}$$

$$k_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$r_q^T = (153.591 \quad 75.6527 \quad 5.64463 \quad 11.4598 \quad -124.156 \quad -12.8665 \quad -9.26359 \quad -26.1217 \quad 54.4939 \quad 14)$$

Gauss point = {s → -0.339981, t → -0.339981}

Weight = 0.425293

$$\mathbf{N}^T = \{0.448887, 0.221103, 0.108906, 0.221103, -0.36286, -0.17873, -0.17873, -0.36286, \\ 0.159264, 0.078447, 0.078447, 0.159264, 0.0584853, 0.0288074, 0.0288074, 0.0584853, 0.29332\}$$

$$\partial \mathbf{N}^T / \partial s = (-0.334995 \quad 0.334995 \quad 0.165005 \quad -0.165005 \quad -0.278977 \quad -0.270795 \quad -0.137413 \quad 0.270795)$$

$$\partial \mathbf{N}^T / \partial t = (-0.334995 \quad -0.165005 \quad 0.165005 \quad 0.334995 \quad 0.270795 \quad -0.137413 \quad -0.270795 \quad -0.278977)$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 39.9204 & 0. \\ -53.4926 & 133.333 \end{pmatrix} \quad \det \mathbf{J} = 0.000187874$$

$$\mathbf{B}^T = \begin{pmatrix} -13.3731 & 13.3731 & 6.58705 & -6.58705 & -11.1369 & -10.8102 & -5.48557 & 10.8102 & -1 \\ -26.7463 & -39.9204 & 13.1741 & 53.4926 & 51.0292 & -3.83617 & -28.7554 & -51.6825 \end{pmatrix}$$

$$k_x = 45.$$

$$k_y = 45.$$

$$p = 0.$$

$$q = 5. \times 10^6$$

$$\mathbf{k}_k = \begin{pmatrix} 3.21517 & 3.19603 & -1.58366 & -4.82755 & -4.37188 & 0.888717 & 3.02912 \\ 3.19603 & 6.37307 & -1.57423 & -7.99487 & -7.86006 & 0.0308299 & 3.86369 \\ -1.58366 & -1.57423 & 0.780045 & 2.37785 & 2.1534 & -0.437745 & -1.49202 \\ -4.82755 & -7.99487 & 2.37785 & 10.4446 & 10.0785 & -0.481802 & -5.40079 \\ -4.37188 & -7.86006 & 2.1534 & 10.0785 & 9.80875 & -0.270977 & -5.05636 \\ 0.888717 & 0.0308299 & -0.437745 & -0.481802 & -0.270977 & 0.473096 & 0.609848 \\ 3.02912 & 3.86369 & -1.49202 & -5.40079 & -5.05636 & 0.609848 & 3.08128 \\ 4.45041 & 7.93813 & -2.19209 & -10.1964 & -9.91554 & 0.292684 & 5.13035 \\ 0.408243 & -1.04614 & -0.201084 & 0.838985 & 1.04138 & 0.500175 & -0.00271117 \\ 2.56856 & 4.4024 & -1.26517 & -5.7058 & -5.52584 & 0.216703 & 2.91321 \\ -2.0736 & -3.91038 & 1.02137 & 4.96261 & 4.85281 & -0.079888 & -2.44689 \\ 4.05332 & 5.48115 & -1.9965 & -7.53797 & -7.10805 & 0.733061 & 4.2061 \\ 2.22386 & 5.78843 & -1.09538 & -6.91691 & -6.95789 & -0.339728 & 3.04961 \\ -3.11867 & -4.44597 & 1.53613 & 6.02852 & 5.7205 & -0.503013 & -3.29724 \\ 0.26007 & 1.60439 & -0.128099 & -1.73636 & -1.83347 & -0.287143 & 0.60405 \\ -6.75808 & -10.2957 & 3.32875 & 13.725 & 13.1234 & -0.91359 & -7.32145 \\ -2.1644 & -2.15151 & 1.06609 & 3.24982 & 2.94307 & -0.598268 & -2.03915 \end{pmatrix}$$

$$\mathbf{k}_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_q^T = (179.334 \quad 88.3324 \quad 43.5089 \quad 88.3324 \quad -144.965 \quad -71.4039 \quad -71.4039 \quad -144.965 \quad 63.6273 \quad 31)$$

$$\text{Gauss point} = \{s \rightarrow -0.339981, t \rightarrow 0.339981\} \quad \text{Weight} = 0.425293$$

$$\mathbf{N}^T = \{0.221103, 0.108906, 0.221103, 0.448887, -0.17873, -0.17873, -0.36286, -0.36286, 0.078447, -0.078447, 0.159264, -0.159264, 0.0288074, 0.0288074, 0.0584853, 0.0584853, 0.29332\}$$

$$\partial \mathbf{N}^T / \partial s = (-0.165005 \quad 0.165005 \quad 0.334995 \quad -0.334995 \quad -0.137413 \quad -0.270795 \quad -0.278977 \quad 0.270795 \quad 0.137413 \quad 0.278977 \quad -0.165005 \quad -0.334995 \quad -0.334995 \quad -0.137413 \quad -0.270795 \quad -0.278977 \quad 0.270795)$$

$$\partial \mathbf{N}^T / \partial t = (-0.334995 \quad -0.165005 \quad 0.165005 \quad 0.334995 \quad 0.270795 \quad 0.137413 \quad -0.270795 \quad 0.278977 \quad 0.137413 \quad 0.278977 \quad -0.334995 \quad -0.165005 \quad 0.165005 \quad 0.334995 \quad 0.270795 \quad 0.137413 \quad -0.270795)$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 50.125 & 0. \\ -67.1665 & 133.333 \end{pmatrix} \quad \det \mathbf{J} = 0.000149626$$

$$\mathbf{B}^T = \begin{pmatrix} -8.27086 & 8.27086 & 16.7916 & -16.7916 & -6.8878 & -13.5736 & -13.9837 & 13.5736 & -8.27086 & 8.27086 & -16.7916 & 16.7916 & 6.8878 & 13.5736 & 13.9837 & -13.5736 & 8.27086 \\ -33.5832 & -33.0834 & -0.499824 & 67.1665 & 45.3355 & 36.51 & -17.3681 & 19.0086 & -4.499824 & -67.1665 & -45.3355 & -36.51 & 17.3681 & -19.0086 & 4.499824 & 67.1665 & 45.3355 \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$k_k = \begin{pmatrix} 3.42553 & 2.98568 & -0.349629 & -6.06158 & -4.1967 & -3.18962 & 2.00145 & -2.1495 \\ 2.98568 & 3.33011 & 0.445048 & -6.76083 & -4.45808 & -3.78032 & 1.3142 & -1.47934 \\ -0.349629 & 0.445048 & 0.808125 & -0.903543 & -0.396081 & -0.704929 & -0.647536 & 0.625466 \\ -6.06158 & -6.76083 & -0.903543 & 13.726 & 9.05086 & 7.67487 & -2.66811 & 3.00337 \\ -4.1967 & -4.45808 & -0.396081 & 9.05086 & 6.02139 & 5.00751 & -1.97894 & 2.20001 \\ -3.18962 & -3.78032 & -0.704929 & 7.67487 & 5.00751 & 4.34469 & -1.27228 & 1.45293 \\ 2.00145 & 1.3142 & -0.647536 & -2.66811 & -1.97894 & -1.27228 & 1.42375 & -1.48892 \\ -2.1495 & -1.47934 & 0.625466 & 3.00337 & 2.20001 & 1.45975 & -1.48892 & 1.560931 \\ 0.625507 & 0.214558 & -0.404467 & -0.435598 & -0.402779 & -0.128018 & 0.560931 & -0.571678 \\ 1.55867 & 1.25536 & -0.265369 & -2.54866 & -1.79613 & -1.30954 & 0.971678 & -1.030954 \\ -3.34818 & -4.11377 & -0.889886 & 8.35184 & 5.41645 & 4.76066 & -1.24951 & 1.45293 \\ 5.06322 & 5.26797 & 0.363924 & -10.6951 & -7.14305 & -5.88945 & 2.45293 & -2.714305 \\ 1.89981 & 2.47059 & 0.645435 & -5.01583 & -3.22333 & -2.8887 & 0.628362 & -0.750981 \\ 3.48953 & 3.54045 & 0.157903 & -7.18789 & -4.82377 & -3.93501 & 1.74385 & -1.91136 \\ 2.16115 & 3.34521 & 1.28513 & -6.79149 & -4.25472 & -4.02103 & 0.398668 & -0.562103 \\ 6.38722 & 6.1893 & -0.0109061 & -12.5656 & -8.5093 & -6.8025 & 3.36406 & -3.670981 \\ 4.08054 & 4.55127 & 0.608249 & -9.24006 & -6.09287 & -5.16659 & 1.79613 & -2.020981 \end{pmatrix}$$

$$k_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$r_q^T = (70.3495 \quad 34.6512 \quad 70.3495 \quad 142.825 \quad -56.8673 \quad -56.8673 \quad -115.453 \quad -115.453 \quad 24.9599 \quad -115.453)$$

Gauss point = {s → -0.339981, t → 0.861136}

Weight = 0.226852

$$\begin{aligned}
\mathbf{N}^T &= \\
&\{0.0465187, 0.0229132, 0.307096, 0.623472, -0.0376036, -0.0522287, -0.503986, -0.106035, 0.0165047, \\
&-0.0580638, 0.221207, -0.117882, 0.00606089, -0.0540071, 0.0812318, -0.109646, 0.0857143\} \\
\partial \mathbf{N}^T / \partial s &= (-0.0347159 \quad 0.0347159 \quad 0.465284 \quad -0.465284 \quad -0.0289107 \quad -0.0791321 \quad -0.387479 \quad 0.0) \\
\partial \mathbf{N}^T / \partial t &= (-0.334995 \quad -0.165005 \quad 0.165005 \quad 0.334995 \quad 0.270795 \quad 0.348052 \quad -0.270795 \quad 0.70662 \quad - \\
\mathbf{J}^{-T} &= \begin{pmatrix} 62.3384 & 0. \\ -83.5323 & 133.333 \end{pmatrix} \quad \det \mathbf{J} = 0.000120311 \\
\mathbf{B}^T &= \begin{pmatrix} -2.16413 & 2.16413 & 29.0051 & -29.0051 & -1.80225 & -4.93297 & -24.1548 & 4.93297 & - \\ -41.7661 & -24.9005 & -16.8656 & 83.5323 & 38.521 & 53.017 & -3.73898 & 87.606 & - \end{pmatrix} \\
k_x &= 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6 \\
\mathbf{k}_k &= \begin{pmatrix} 2.14819 & 1.27155 & 0.788047 & -4.20779 & -1.97119 & -2.70646 & 0.255997 & -4. \\ 1.27155 & 0.767266 & 0.592881 & -2.6317 & -1.18285 & -1.63449 & 0.0501442 & -2. \\ 0.788047 & 0.592881 & 1.38261 & -2.76354 & -0.862123 & -1.27392 & -0.783026 & -1. \\ -4.20779 & -2.6317 & -2.76354 & 9.60302 & 4.01616 & 5.61486 & 0.476885 & 8. \\ -1.97119 & -1.18285 & -0.862123 & 4.01616 & 1.82644 & 2.51918 & -0.123427 & 4. \\ -2.70646 & -1.63449 & -1.27392 & 5.61486 & 2.51918 & 3.48204 & -0.0971173 & 5. \\ 0.255997 & 0.0501442 & -0.783026 & 0.476885 & -0.123427 & -0.0971173 & 0.733757 & -0. \\ -4.50696 & -2.66607 & -1.63893 & 8.81197 & 4.13377 & 5.6745 & -0.548641 & 9. \\ 0.665211 & 0.387108 & 0.186593 & -1.23891 & -0.603098 & -0.82332 & 0.125331 & -1. \\ -2.54766 & -1.54216 & -1.23002 & 5.31984 & 2.3753 & 3.28567 & -0.0666831 & 5. \\ -2.79249 & -1.79195 & -2.227 & 6.81144 & 2.71527 & 3.8273 & 0.631635 & 5. \\ -4.07422 & -2.40574 & -1.44397 & 7.92393 & 3.73208 & 5.12 & -0.52612 & 8. \\ 0.518819 & 0.323459 & 0.331849 & -1.17413 & -0.49406 & -0.690024 & -0.0516673 & -1. \\ -1.6239 & -0.989791 & -0.842933 & 3.45662 & 1.52152 & 2.10945 & 0.00473852 & 3. \\ 2.65408 & 1.77191 & 2.71148 & -7.13747 & -2.65631 & -3.79051 & -1.07737 & -5. \\ -2.2755 & -1.33499 & -0.731682 & 4.34217 & 2.0749 & 2.84035 & -0.353819 & 4. \\ 4.17817 & 2.50841 & 1.83794 & -8.52452 & -3.8727 & -5.34242 & 0.253143 & -8. \end{pmatrix}
\end{aligned}$$

$$\mathbf{k}_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_q^T = (6.34812 \quad 3.12682 \quad 41.9076 \quad 85.0814 \quad -5.13154 \quad -7.12733 \quad -68.776 \quad -14.47 \quad 2.2523 \quad -7.923$$

$$\text{Gauss point} = \{s \rightarrow 0.339981, t \rightarrow -0.861136\} \quad \text{Weight} = 0.226852$$

$$\mathbf{N}^T = \{0.307096, 0.623472, 0.0465187, 0.0229132, -0.503986, -0.106035, -0.0376036, -0.0522287, -0.221207, 0.117882, -0.0165047, 0.0580638, 0.0812318, -0.109646, 0.00606089, -0.0540071, 0.0857143\}$$

$$\partial \mathbf{N}^T / \partial s = (-0.465284 \quad 0.465284 \quad 0.0347159 \quad -0.0347159 \quad 0.387479 \quad -0.0791321 \quad 0.0289107 \quad 0.0791321 \quad -0.0289107 \quad -0.387479 \quad 0.0791321 \quad -0.0791321 \quad 0.0347159 \quad -0.0347159 \quad 0.00606089 \quad -0.00606089 \quad 0.0540071 \quad -0.0857143)$$

$$\partial \mathbf{N}^T / \partial t = (-0.165005 \quad -0.334995 \quad 0.334995 \quad 0.165005 \quad 0.270795 \quad -0.70662 \quad -0.270795 \quad -0.348052 \quad 0.348052 \quad 0.70662 \quad -0.270795 \quad -0.165005 \quad -0.334995 \quad 0.334995 \quad -0.165005 \quad 0.00606089 \quad -0.00606089 \quad 0.0540071 \quad -0.0857143)$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 34.5321 & 0. \\ -22.7919 & 133.333 \end{pmatrix} \quad \det \mathbf{J} = 0.000217189$$

$$\mathbf{B}^T = \begin{pmatrix} -16.0673 & 16.0673 & 1.19882 & -1.19882 & 13.3805 & -2.7326 & 0.99835 & 2.7326 & -16.0673 \\ -11.3959 & -55.2707 & 43.8748 & 22.7919 & 27.2746 & -92.4125 & -36.7649 & -48.2105 & 26.8117 \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$k_k = \begin{pmatrix} 0.860303 & 0.824121 & -1.15126 & -0.533162 & -1.16579 & 2.43227 & 0.893351 & 1.1 \\ 0.824121 & 7.3454 & -5.33383 & -2.83569 & -2.86565 & 11.2271 & 4.54084 & 6.0 \\ -1.15126 & -5.33383 & 4.27117 & 2.21393 & 2.68874 & -8.99682 & -3.57371 & -4.6 \\ -0.533162 & -2.83569 & 2.21393 & 1.15492 & 1.3427 & -4.66259 & -1.86049 & -2.4 \\ -1.16579 & -2.86565 & 2.68874 & 1.3427 & 2.04629 & -5.6694 & -2.19362 & -2.8 \\ 2.43227 & 11.2271 & -8.99682 & -4.66259 & -5.6694 & 18.9511 & 7.52676 & 9.8 \\ 0.893351 & 4.54084 & -3.57371 & -1.86049 & -2.19362 & 7.52676 & 2.99903 & 3.9 \\ 1.12076 & 6.00519 & -4.68248 & -2.44347 & -2.8343 & 9.86134 & 3.93582 & 5.1 \\ -0.0859756 & -3.8754 & 2.56296 & 1.39842 & 1.12835 & -5.39066 & -2.22133 & -2.9 \\ -2.24284 & -10.2448 & 8.22646 & 4.26117 & 5.19906 & -17.3286 & -6.87988 & -9.0 \\ 0.423867 & 1.79773 & -1.46537 & -0.756224 & -0.945632 & 3.08705 & 1.22241 & 1.5 \\ -1.01882 & -5.57441 & 4.33108 & 2.26216 & 2.6073 & -9.12105 & -3.64272 & -4.7 \\ 0.616021 & -2.1706 & 0.957315 & 0.597268 & -0.0983026 & -2.00498 & -0.912101 & -1.2 \\ 1.34037 & 5.91201 & -4.78046 & -2.47192 & -3.05092 & 10.0703 & 3.99325 & 5.2 \\ -0.112046 & -0.928302 & 0.679767 & 0.360581 & 0.370838 & -1.43093 & -0.577813 & -0.7 \\ 0.580305 & 3.40336 & -2.61422 & -1.36944 & -1.54597 & 5.50498 & 2.20314 & 2.8 \\ -1.88117 & -9.59798 & 7.54863 & 3.93052 & 4.62883 & -15.8985 & -6.33549 & -8.3 \end{pmatrix}$$

$$k_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$r_q^T = (75.6527 \quad 153.591 \quad 11.4598 \quad 5.64463 \quad -124.156 \quad -26.1217 \quad -9.26359 \quad -12.8665 \quad -54.4939 \quad 2$$

Gauss point = {s → 0.339981, t → -0.339981}

Weight = 0.425293

$$\mathbf{N}^T = \{0.221103, 0.448887, 0.221103, 0.108906, -0.36286, -0.36286, -0.17873, -0.17873, -0.159264, 0.159264, -0.078447, 0.078447, 0.0584853, 0.0584853, 0.0288074, 0.0288074, 0.29332\}$$

$$\partial \mathbf{N}^T / \partial s = \begin{pmatrix} -0.334995 & 0.334995 & 0.165005 & -0.165005 & 0.278977 & -0.270795 & 0.137413 & 0.270795 \end{pmatrix}$$

$$\partial \mathbf{N}^T / \partial t = \begin{pmatrix} -0.165005 & -0.334995 & 0.334995 & 0.165005 & 0.270795 & -0.278977 & -0.270795 & -0.137413 \end{pmatrix}$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 39.9204 & 0. \\ -26.3482 & 133.333 \end{pmatrix} \quad \det \mathbf{J} = 0.000187874$$

$$\mathbf{B}^T = \begin{pmatrix} -13.3731 & 13.3731 & 6.58705 & -6.58705 & 11.1369 & -10.8102 & 5.48557 & 10.8102 & -13.3731 \\ -13.1741 & -53.4926 & 40.3185 & 26.3482 & 28.7554 & -30.062 & -39.7266 & -25.4567 & 24.9204 \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$\mathbf{k}_k = \begin{pmatrix} 1.26707 & 1.89082 & -2.22655 & -0.931341 & -1.89761 & 1.94379 & 1.61802 & 0.686041 \\ 1.89082 & 10.9316 & -7.43797 & -5.38445 & -4.99521 & 5.26221 & 7.90463 & 5.41604 \\ -2.22655 & -7.43797 & 6.00089 & 3.66363 & 4.43238 & -4.61406 & -5.62915 & -3.43436 \\ -0.931341 & -5.38445 & 3.66363 & 2.65215 & 2.46043 & -2.59195 & -3.89349 & -2.66771 \\ -1.89761 & -4.99521 & 4.43238 & 2.46043 & 3.41905 & -3.54106 & -3.88776 & -2.19911 \\ 1.94379 & 5.26221 & -4.61406 & -2.59195 & -3.54106 & 3.66959 & 4.08083 & 2.33143 \\ 1.61802 & 7.90463 & -5.62915 & -3.89349 & -3.88776 & 4.08083 & 5.78273 & 3.84944 \\ 0.686041 & 5.41604 & -3.43436 & -2.66771 & -2.19914 & 2.33143 & 3.84944 & 2.75021 \\ -0.518339 & -5.46564 & 3.29183 & 2.69215 & 2.02798 & -2.16148 & -3.83828 & -2.82181 \\ 2.10548 & 9.70367 & -7.02953 & -4.77963 & -4.90367 & 5.14068 & 7.13064 & 4.69371 \\ 0.865102 & 1.85722 & -1.80753 & -0.914788 & -1.44666 & 1.49202 & 1.48804 & 0.77501 \\ 1.15619 & 3.5401 & -2.95258 & -1.7437 & -2.21565 & 2.30212 & 2.70492 & 1.60881 \\ 0.622185 & -2.48664 & 0.639641 & 1.22482 & -0.020772 & -0.0399649 & -1.51737 & -1.51271 \\ -3.28873 & -12.9297 & 9.84979 & 6.36863 & 7.06529 & -7.3811 & -9.63017 & -6.12521 \\ -0.104977 & -2.89544 & 1.57425 & 1.42617 & 0.887829 & -0.958551 & -1.9881 & -1.54011 \\ -1.57615 & -6.82381 & 5.03883 & 3.36113 & 3.5534 & -3.72007 & -5.03989 & -3.27521 \\ -1.27287 & -7.35895 & 5.0071 & 3.62471 & 3.36268 & -3.54243 & -5.32125 & -3.64591 \end{pmatrix}$$

$$\mathbf{k}_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_q^T = (88.3324 \quad 179.334 \quad 88.3324 \quad 43.5089 \quad -144.965 \quad -144.965 \quad -71.4039 \quad -71.4039 \quad -63.6273$$

$$\text{Gauss point} = \{s \rightarrow 0.339981, t \rightarrow 0.339981\} \quad \text{Weight} = 0.425293$$

$$\mathbf{N}^T = \{0.108906, 0.221103, 0.448887, 0.221103, -0.17873, -0.36286, -0.36286, -0.17873, -0.078447, \\ -0.159264, -0.159264, -0.078447, 0.0288074, 0.0584853, 0.0584853, 0.0288074, 0.29332\}$$

$$\partial \mathbf{N}^T / \partial s = (-0.165005 \quad 0.165005 \quad 0.334995 \quad -0.334995 \quad 0.137413 \quad -0.270795 \quad 0.278977 \quad 0.270795$$

$$\partial \mathbf{N}^T / \partial t = (-0.165005 \quad -0.334995 \quad 0.334995 \quad 0.165005 \quad 0.270795 \quad 0.278977 \quad -0.270795 \quad 0.137413$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 50.125 & 0. \\ -33.0834 & 133.333 \end{pmatrix} \quad \det \mathbf{J} = 0.000149626$$

$$\mathbf{B}^T = \begin{pmatrix} -8.27086 & 8.27086 & 16.7916 & -16.7916 & 6.8878 & -13.5736 & 13.9837 & 13.5736 & -8.54 \\ -16.5417 & -50.125 & 33.5832 & 33.0834 & 31.5599 & 46.1558 & -45.3355 & 9.36286 & 21.48 \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$k_k = \begin{pmatrix} 0.979443 & 2.17845 & -1.98848 & -1.16941 & -1.65808 & -1.86485 & 1.81628 & -0.76485 \\ 2.17845 & 7.39065 & -4.42273 & -5.14637 & -4.36687 & -6.94652 & 6.8385 & -1.02243 \\ -1.98848 & -4.42273 & 4.03705 & 2.37416 & 3.36625 & 3.78604 & -3.68744 & 1.55308 \\ -1.16941 & -5.14637 & 2.37416 & 3.94163 & 2.65869 & 5.02533 & -4.96734 & 0.234335 \\ -1.65808 & -4.36687 & 3.36625 & 2.65869 & 2.98805 & 3.90357 & -3.82135 & 1.11388 \\ -1.86485 & -6.94652 & 3.78604 & 5.02533 & 3.90357 & 6.62803 & -6.53556 & 0.709903 \\ 1.81628 & 6.8385 & -3.68744 & -4.96734 & -3.82135 & -6.53556 & 6.44549 & -0.671969 \\ -0.76485 & -1.02243 & 1.55308 & 0.234335 & 1.11388 & 0.709903 & -0.671969 & 0.771124 \\ -0.815419 & -3.28631 & 1.65548 & 2.44625 & 1.77326 & 3.17182 & -3.13139 & 0.244625 \\ 2.14013 & 5.91638 & -4.34492 & -3.71158 & -3.93145 & -5.34625 & 5.24012 & -1.36625 \\ 0.619207 & 0.220858 & -1.25712 & 0.417058 & -0.739763 & 0.0925124 & -0.123218 & -0.79763 \\ 1.12154 & 3.96717 & -2.27697 & -2.81175 & -2.29148 & -3.75467 & 3.69906 & -0.48763 \\ 0.179082 & -0.673564 & -0.363574 & 0.858056 & -0.0172251 & 0.837602 & -0.846483 & -0.42251 \\ 3.276 & 10.1358 & -6.651 & -6.76084 & -6.306 & -9.37055 & 9.2081 & -1.79763 \\ -0.471738 & -3.89866 & 0.957731 & 3.41266 & 1.55872 & 4.03126 & -4.00787 & -0.39763 \\ 1.58887 & 4.6058 & -3.22575 & -2.96892 & -2.9757 & -4.20377 & 4.12498 & -0.95763 \\ 1.33861 & 2.9773 & -2.71767 & -1.59824 & -2.2661 & -2.5487 & 2.48232 & -1.04763 \end{pmatrix}$$

$$k_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$r_q^T = (34.6512 \quad 70.3495 \quad 142.825 \quad 70.3495 \quad -56.8673 \quad -115.453 \quad -115.453 \quad -56.8673 \quad -24.9599 \quad .$$

Gauss point = {s → 0.339981, t → 0.861136}

Weight = 0.226852

$$\mathbf{N}^T = \{0.0229132, 0.0465187, 0.623472, 0.307096, -0.0376036, -0.106035, -0.503986, -0.0522287, -0.0165047, -0.117882, -0.221207, -0.0580638, 0.00606089, -0.109646, 0.0812318, -0.0540071, 0.0857143\}$$

$$\partial \mathbf{N}^T / \partial s = (-0.0347159 \quad 0.0347159 \quad 0.465284 \quad -0.465284 \quad 0.0289107 \quad -0.0791321 \quad 0.387479 \quad 0.0791321)$$

$$\partial \mathbf{N}^T / \partial t = (-0.165005 \quad -0.334995 \quad 0.334995 \quad 0.165005 \quad 0.270795 \quad 0.70662 \quad -0.270795 \quad 0.348052 \quad 0)$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 62.3384 & 0. \\ -41.1445 & 133.333 \end{pmatrix} \quad \det \mathbf{J} = 0.000120311$$

$$\mathbf{B}^T = \begin{pmatrix} -2.16413 & 2.16413 & 29.0051 & -29.0051 & 1.80225 & -4.93297 & 24.1548 & 4.93297 & -2.2051 \\ -20.5723 & -46.0944 & 25.5221 & 41.1445 & 34.9165 & 97.4719 & -52.0487 & 43.1511 & 17.3125 \end{pmatrix}$$

$$k_x = 45.$$

$$k_y = 45.$$

$$p = 0.$$

$$q = 5. \times 10^6$$

$$\mathbf{k}_k = \begin{pmatrix} 0.525538 & 1.15889 & -0.721945 & -0.962478 & -0.887002 & -2.44965 & 1.25088 & -1.10338 \\ 1.15889 & 2.61525 & -1.36777 & -2.40637 & -1.9719 & -5.53119 & 3.01078 & -2.42976 \\ -0.721945 & -1.36777 & 1.83327 & 0.256446 & 1.15868 & 2.87959 & -0.771025 & 1.52833 \\ -0.962478 & -2.40637 & 0.256446 & 3.1124 & 1.70022 & 5.10125 & -3.49063 & 2.00481 \\ -0.887002 & -1.9719 & 1.15868 & 1.70022 & 1.50133 & 4.16903 & -2.17857 & 1.86139 \\ -2.44965 & -5.53119 & 2.87959 & 5.10125 & 4.16903 & 11.6985 & -6.37722 & 5.13584 \\ 1.25088 & 3.01078 & -0.771025 & -3.49063 & -2.17857 & -6.37722 & 4.04379 & -2.61208 \\ -1.10338 & -2.42976 & 1.52833 & 2.00481 & 1.86139 & 5.13584 & -2.61208 & 2.31718 \\ -0.431741 & -0.986616 & 0.463365 & 0.954991 & 0.737913 & 2.08729 & -1.17367 & 0.902709 \\ -2.26216 & -5.11586 & 2.62918 & 4.74884 & 3.85208 & 10.8205 & -5.92293 & 4.74884 \\ -0.0195576 & -0.301861 & -0.944161 & 1.26558 & 0.10203 & 0.651442 & -1.13969 & 0.02709 \\ -0.999503 & -2.19226 & 1.41727 & 1.77449 & 1.68382 & 4.63338 & -2.32921 & 2.092709 \\ 0.100301 & 0.19602 & -0.232208 & -0.0641138 & -0.162577 & -0.413046 & 0.132441 & -0.21718 \\ -1.35834 & -3.08745 & 1.52028 & 2.92551 & 2.31718 & 6.53101 & -3.62229 & 2.84914 \\ -0.773428 & -2.11782 & -0.484914 & 3.37617 & 1.41538 & 4.49796 & -3.58289 & 1.60336 \\ -0.562336 & -1.21604 & 0.862531 & 0.915843 & 0.942709 & 2.56922 & -1.2371 & 1.18667 \\ 1.8667 & 4.14715 & -2.44864 & -3.56521 & -3.15883 & -8.76784 & 4.57332 & -3.9125 \end{pmatrix}$$

$$\mathbf{k}_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_q^T = (3.12682 \quad 6.34812 \quad 85.0814 \quad 41.9076 \quad -5.13154 \quad -14.47 \quad -68.776 \quad -7.12733 \quad -2.2523 \quad -16.0$$

$$\text{Gauss point} = \{s \rightarrow 0.861136, t \rightarrow -0.861136\} \quad \text{Weight} = 0.121003$$

$$\mathbf{N}^T = \{0.0646111, 0.865957, 0.0646111, 0.00482078, -0.147276, -0.147276, -0.0109886, -0.0109886, -0.16373, 0.16373, -0.0122162, 0.0122162, -0.15229, -0.15229, -0.0113627, -0.0113627, 0.0250475\}$$

$$\partial \mathbf{N}^T / \partial s = (-0.465284 \quad 0.465284 \quad 0.0347159 \quad -0.0347159 \quad 0.981444 \quad -0.0791321 \quad 0.0732278 \quad 0.0791321 \quad -0.0347159 \quad 0.0347159 \quad -0.465284 \quad 0.465284 \quad -0.0791321 \quad 0.0791321 \quad -0.0113627 \quad 0.0113627 \quad 0.0250475)$$

$$\partial \mathbf{N}^T / \partial t = (-0.0347159 \quad -0.465284 \quad 0.465284 \quad 0.0347159 \quad 0.0791321 \quad -0.981444 \quad -0.0791321 \quad -0.0113627 \quad 0.0347159 \quad 0.465284 \quad -0.0347159 \quad -0.465284 \quad -0.0791321 \quad 0.0791321 \quad -0.0113627 \quad 0.0113627 \quad 0.0250475)$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 34.5321 & 0. \\ -4.79526 & 133.333 \end{pmatrix} \quad \det \mathbf{J} = 0.000217189$$

$$\mathbf{B}^T = \begin{pmatrix} -16.0673 & 16.0673 & 1.19882 & -1.19882 & 33.8914 & -2.7326 & 2.52871 & 2.7326 & 31 \\ -2.39763 & -64.269 & 61.8714 & 4.79526 & 5.84466 & -130.48 & -10.9021 & -10.1432 & 7 \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$k_k = \begin{pmatrix} 0.312101 & -0.123068 & -0.198215 & 0.00918237 & -0.66056 & 0.421898 & -0.0171366 \\ -0.123068 & 5.19014 & -4.67982 & -0.387248 & 0.199758 & 9.86533 & 0.876674 \\ -0.198215 & -4.67982 & 4.52886 & 0.349172 & 0.475706 & -9.55115 & -0.794127 \\ 0.00918237 & -0.387248 & 0.349172 & 0.0288935 & -0.0149044 & -0.736075 & -0.0654107 \\ -0.66056 & 0.199758 & 0.475706 & -0.0149044 & 1.39879 & -1.0114 & 0.0259972 \\ 0.421898 & 9.86533 & -9.55115 & -0.736075 & -1.0114 & 20.143 & 1.67411 \\ -0.0171366 & 0.876674 & -0.794127 & -0.0654107 & 0.0259972 & 1.67411 & 0.148123 \\ -0.0231626 & 0.822866 & -0.738307 & -0.0613959 & 0.0394147 & 1.55635 & 0.138948 \\ -0.612187 & 0.0280208 & 0.586257 & -0.00209069 & 1.29821 & -1.24387 & -0.0024881 \\ -0.397151 & -9.04068 & 8.76329 & 0.674546 & 0.949175 & -18.4815 & -1.5343 \\ -0.00993557 & 0.960139 & -0.878565 & -0.0716382 & 0.00973712 & 1.85223 & 0.16233 \\ 0.0311137 & -0.771033 & 0.682391 & 0.0575286 & -0.0568923 & -1.43835 & -0.130085 \\ -0.371846 & -0.287751 & 0.638127 & 0.0214698 & 0.792139 & -1.35017 & -0.0530751 \\ 0.25316 & 5.29309 & -5.15132 & -0.39493 & -0.599493 & 10.8642 & 0.898536 \\ 0.00549974 & 0.869643 & -0.810257 & -0.0648861 & -0.0219349 & 1.70841 & 0.147201 \\ -0.0376132 & 0.484676 & -0.4109 & -0.0361628 & 0.07406 & 0.865859 & 0.0815581 \\ 0.0441495 & -1.86192 & 1.67885 & 0.138922 & -0.0716615 & -3.5391 & -0.314499 \end{pmatrix}$$

$$k_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$r_q^T = (8.49006 \quad 113.789 \quad 8.49006 \quad 0.633463 \quad -19.3524 \quad -19.3524 \quad -1.44393 \quad -1.44393 \quad -21.5145$$

Gauss point = {s → 0.861136, t → -0.339981}

Weight = 0.226852

$$\begin{aligned}
\mathbf{N}^T &= \\
&\{0.0465187, 0.623472, 0.307096, 0.0229132, -0.106035, -0.503986, -0.0522287, -0.0376036, -0.117882, \\
&0.221207, -0.0580638, 0.0165047, -0.109646, 0.0812318, -0.0540071, 0.00606089, 0.0857143\} \\
\partial \mathbf{N}^T / \partial s &= (-0.334995 \quad 0.334995 \quad 0.165005 \quad -0.165005 \quad 0.70662 \quad -0.270795 \quad 0.348052 \quad 0.270795 \quad 0 \\
\partial \mathbf{N}^T / \partial t &= (-0.0347159 \quad -0.465284 \quad 0.465284 \quad 0.0347159 \quad 0.0791321 \quad -0.387479 \quad -0.0791321 \quad -0.0 \\
\mathbf{J}^{-T} &= \begin{pmatrix} 39.9204 & 0. \\ -5.54349 & 133.333 \end{pmatrix} \quad \det \mathbf{J} = 0.000187874 \\
\mathbf{B}^T &= \begin{pmatrix} -13.3731 & 13.3731 & 6.58705 & -6.58705 & 28.2086 & -10.8102 & 13.8944 & 10.8102 & 25.89 \\ -2.77175 & -63.8949 & 61.1232 & 5.54349 & 6.6338 & -50.1628 & -12.4804 & -5.35591 & 8.13 \end{pmatrix} \\
k_x &= 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6 \\
\mathbf{k}_k &= \begin{pmatrix} 0.35773 & -0.00333785 & -0.493868 & 0.139477 & -0.75876 & 0.543921 & -0.29002 \\ -0.00333785 & 8.17286 & -7.32126 & -0.84826 & -0.0894287 & 5.86982 & 1.88574 \\ -0.493868 & -7.32126 & 7.2485 & 0.566631 & 1.13402 & -6.01699 & -1.2875 \\ 0.139477 & -0.84826 & 0.566631 & 0.142152 & -0.285835 & -0.39675 & -0.308218 \\ -0.75876 & -0.0894287 & 1.13402 & -0.285835 & 1.6105 & -1.22305 & 0.592908 \\ 0.543921 & 5.86982 & -6.01699 & -0.39675 & -1.22305 & 5.05009 & 0.912619 \\ -0.29002 & 1.88574 & -1.2875 & -0.308218 & 0.592908 & 0.912619 & 0.668981 \\ -0.248791 & 0.93359 & -0.491289 & -0.19351 & 0.516699 & 0.291146 & 0.416267 \\ -0.707404 & -0.332572 & 1.28064 & -0.240664 & 1.50444 & -1.3194 & 0.495362 \\ 0.222431 & 8.05455 & -7.52879 & -0.748192 & -0.566922 & 6.12957 & 1.67593 \\ -0.255371 & 1.98158 & -1.42154 & -0.304674 & 0.518282 & 1.03443 & 0.663047 \\ 0.143606 & 0.38343 & -0.543153 & 0.0161171 & -0.309138 & 0.494936 & -0.027773 \\ -0.437844 & -0.686378 & 1.22338 & -0.0991596 & 0.93684 & -1.16206 & 0.195886 \\ -0.551452 & -11.6373 & 11.1973 & 0.991515 & 1.30713 & -9.20747 & -2.23538 \\ -0.1291 & 1.65742 & -1.30635 & -0.221971 & 0.254268 & 0.994249 & 0.486259 \\ 0.00549571 & -0.948174 & 0.84228 & 0.100398 & -0.000460782 & -0.673186 & -0.222905 \\ 0.5213 & -2.0496 & 1.11315 & 0.41515 & -1.08155 & -0.677199 & -0.893742 \end{pmatrix}
\end{aligned}$$

$$\mathbf{k}_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_q^T = (9.91303 \quad 132.86 \quad 65.4415 \quad 4.88274 \quad -22.5959 \quad -107.398 \quad -11.1298 \quad -8.01324 \quad -25.1204 \quad 4$$

$$\text{Gauss point} = \{s \rightarrow 0.861136, t \rightarrow 0.339981\} \quad \text{Weight} = 0.226852$$

$$\mathbf{N}^T = \{0.0229132, 0.307096, 0.623472, 0.0465187, -0.0522287, -0.503986, -0.106035, -0.0376036, -0.0580638, \\ -0.221207, -0.117882, -0.0165047, -0.0540071, 0.0812318, -0.109646, 0.00606089, 0.0857143\}$$

$$\partial \mathbf{N}^T / \partial s = (-0.165005 \quad 0.165005 \quad 0.334995 \quad -0.334995 \quad 0.348052 \quad -0.270795 \quad 0.70662 \quad 0.270795 \quad 0$$

$$\partial \mathbf{N}^T / \partial t = (-0.0347159 \quad -0.465284 \quad 0.465284 \quad 0.0347159 \quad 0.0791321 \quad 0.387479 \quad -0.0791321 \quad 0.0289$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 50.125 & 0. \\ -6.96054 & 133.333 \end{pmatrix} \quad \det \mathbf{J} = 0.000149626$$

$$\mathbf{B}^T = \begin{pmatrix} -8.27086 & 8.27086 & 16.7916 & -16.7916 & 17.4461 & -13.5736 & 35.4193 & 13.5736 & 16.01 \\ -3.48027 & -63.1864 & 59.7061 & 6.96054 & 8.12831 & 53.5488 & -15.4694 & 1.96989 & 9.50 \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$k_k = \begin{pmatrix} 0.122988 & 0.231404 & -0.529522 & 0.17513 & -0.263609 & -0.113181 & -0.365225 & -0.000000 \\ 0.231404 & 6.20279 & -5.55028 & -0.883914 & -0.564088 & -5.33963 & 1.94046 & -0.000000 \\ -0.529522 & -5.55028 & 5.8757 & 0.204108 & 1.18874 & 4.53536 & -0.502327 & 0.000000 \\ 0.17513 & -0.883914 & 0.204108 & 0.504675 & -0.36104 & 0.917454 & -1.0729 & -0.000000 \\ -0.263609 & -0.564088 & 1.18874 & -0.36104 & 0.565815 & 0.303127 & 0.751784 & 0.000000 \\ -0.113181 & -5.33963 & 4.53536 & 0.917454 & 0.303127 & 4.66129 & -1.99962 & -0.000000 \\ -0.365225 & 1.94046 & -0.502327 & -1.0729 & 0.751784 & -1.99962 & 2.28173 & 0.000000 \\ -0.181949 & -0.0186419 & 0.527784 & -0.327193 & 0.386162 & -0.120297 & 0.687794 & 0.000000 \\ -0.252857 & -0.715103 & 1.27766 & -0.309702 & 0.544793 & 0.445453 & 0.641838 & 0.000000 \\ 0.411489 & 6.02911 & -5.92095 & -0.519648 & -0.944025 & -5.04977 & 1.17217 & -0.000000 \\ -0.324409 & 1.9786 & -0.647541 & -1.00665 & 0.664758 & -2.00282 & 2.14291 & 0.000000 \\ -0.0454514 & 0.616527 & -0.358649 & -0.212427 & 0.0891291 & -0.582225 & 0.454825 & 0.000000 \\ -0.170178 & -0.807439 & 1.11743 & -0.139814 & 0.370508 & 0.589724 & 0.283371 & 0.000000 \\ 0.482026 & 9.28091 & -8.6875 & -1.07544 & -1.13204 & -7.88726 & 2.38376 & -0.000000 \\ -0.169754 & 1.55147 & -0.746375 & -0.635341 & 0.341753 & -1.5068 & 1.35647 & 0.000000 \\ 0.0639303 & 0.631261 & -0.67872 & -0.0164715 & -0.14306 & -0.513041 & 0.0429531 & -0.000000 \\ 0.387279 & 0.102595 & -1.17307 & 0.683193 & -0.822689 & 0.200125 & -1.4353 & -0.000000 \end{pmatrix}$$

$$k_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$r_q^T = (3.8887 \quad 52.1188 \quad 105.812 \quad 7.89491 \quad -8.86397 \quad -85.5339 \quad -17.9958 \quad -6.38189 \quad -9.85428 \quad -5.00000)$$

Gauss point = {s → 0.861136, t → 0.861136}

Weight = 0.121003

$$\mathbf{N}^T = \{0.00482078, 0.0646111, 0.865957, 0.0646111, \\ -0.0109886, -0.147276, -0.147276, -0.0109886, -0.0122162, -0.16373, \\ -0.16373, -0.0122162, -0.0113627, -0.15229, -0.15229, -0.0113627, 0.0250475\}$$

$$\partial \mathbf{N}^T / \partial s = \begin{pmatrix} -0.0347159 & 0.0347159 & 0.465284 & -0.465284 & 0.0732278 & -0.0791321 & 0.981444 & 0.0791321 \end{pmatrix}$$

$$\partial \mathbf{N}^T / \partial t = \begin{pmatrix} -0.0347159 & -0.465284 & 0.465284 & 0.0347159 & 0.0791321 & 0.981444 & -0.0791321 & 0.0732278 \end{pmatrix}$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 62.3384 & 0. \\ -8.65654 & 133.333 \end{pmatrix} \quad \det \mathbf{J} = 0.000120311$$

$$\mathbf{B}^T = \begin{pmatrix} -2.16413 & 2.16413 & 29.0051 & -29.0051 & 4.56491 & -4.93297 & 61.1817 & 4.93297 & 4.190 \\ -4.32827 & -62.3384 & 58.0101 & 8.65654 & 9.91704 & 131.544 & -19.0469 & 9.0787 & 11.147 \end{pmatrix}$$

$$k_x = 45.$$

$$k_y = 45.$$

$$p = 0.$$

$$q = 5. \times 10^6$$

$$\mathbf{k}_k = \begin{pmatrix} 0.015341 & 0.173692 & -0.205609 & 0.0165763 & -0.0345916 & -0.365999 & -0.0327329 & - \\ 0.173692 & 2.54888 & -2.32793 & -0.394642 & -0.398525 & -5.37907 & 0.864585 & - \\ -0.205609 & -2.32793 & 2.7557 & -0.222165 & 0.463618 & 4.90535 & 0.438706 & \\ 0.0165763 & -0.394642 & -0.222165 & 0.600231 & -0.0305007 & 0.83972 & -1.27056 & - \\ -0.0345916 & -0.398525 & 0.463618 & -0.0305007 & 0.07808 & 0.839859 & 0.059222 & \\ -0.365999 & -5.37907 & 4.90535 & 0.83972 & 0.839859 & 11.3519 & -1.8391 & \\ -0.0327329 & 0.864585 & 0.438706 & -1.27056 & 0.059222 & -1.8391 & 2.68987 & \\ -0.0327363 & -0.363767 & 0.438752 & -0.0422486 & 0.0737342 & 0.766424 & 0.0844348 & \\ -0.0375507 & -0.449318 & 0.503277 & -0.016408 & 0.0849565 & 0.94713 & 0.028861 & \\ -0.335007 & -4.94473 & 4.48997 & 0.78977 & 0.768991 & 10.4355 & -1.72824 & \\ -0.0242529 & 0.877159 & 0.325052 & -1.17796 & 0.0410862 & -1.86443 & 2.49479 & \\ -0.0310304 & -0.327162 & 0.415888 & -0.0576953 & 0.0696834 & 0.68905 & 0.11747 & \\ -0.0334627 & -0.428064 & 0.448488 & 0.0130388 & 0.0760343 & 0.902693 & -0.0329532 & \\ -0.195357 & -2.92504 & 2.6183 & 0.502104 & 0.448923 & 6.17355 & -1.09596 & \\ -0.00293122 & 0.680004 & 0.039286 & -0.716359 & -0.00181224 & -1.44286 & 1.51904 & \\ -0.0201891 & -0.179387 & 0.270587 & -0.0710108 & 0.0449425 & 0.377313 & 0.14743 & \\ 0.0737606 & 0.835124 & -0.988584 & 0.0797 & -0.166319 & -1.75975 & -0.157382 & - \end{pmatrix}$$

$$\mathbf{r}_q^T = (0.350905 \quad 4.70304 \quad 63.033 \quad 4.70304 \quad -0.799858 \quad -10.7202 \quad -10.7202 \quad -0.799858 \quad -0.88922)$$

Adding contributions from all Gauss points

$$k_k = \begin{pmatrix} 25.1402 & 19.8598 & -5.96963 & -39.0304 & -29.6457 & - \\ 19.8598 & 70.1402 & -39.0304 & -50.9696 & -43.839 & - \\ -5.96963 & -39.0304 & 44.3107 & 0.689252 & 14.1933 & - \\ -39.0304 & -50.9696 & 0.689252 & 89.3107 & 59.2914 & - \\ -29.6457 & -43.839 & 14.1933 & 59.2914 & 58.5981 & - \\ -5.43695 & 5.43695 & -20.0595 & 20.0595 & 4.76636 & - \\ 4.17787 & 32.5645 & -28.3866 & -8.35574 & -13.6963 & - \\ 5.43695 & 31.3054 & -16.6829 & -20.0595 & -34.7664 & - \\ 7.65449 & -7.65449 & 15.309 & -15.309 & -8.97663 & - \\ -1.29299 & 1.29299 & -2.58597 & 2.58597 & -0.904903 & - \\ -1.07872 & 1.07872 & -2.15744 & 2.15744 & 6.33432 & - \\ 1.29299 & -1.29299 & 2.58597 & -2.58597 & 0.904903 & - \\ -2.22045 \times 10^{-16} & 1.11022 \times 10^{-15} & -2.22045 \times 10^{-16} & 8.88178 \times 10^{-16} & -1.65193 & - \\ -0.152988 & 0.152988 & -0.305977 & 0.305977 & -0.10707 & - \\ 1.33227 \times 10^{-15} & 9.99201 \times 10^{-16} & 1.33227 \times 10^{-15} & -2.66454 \times 10^{-15} & -0.624062 & - \\ 0.152988 & -0.152988 & 0.305977 & -0.305977 & 0.10707 & - \\ 10.2336 & -10.2336 & 20.4673 & -20.4673 & -7.82921 & - \end{pmatrix}$$

$$k_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$r_q^T = (937.5 \quad 937.5 \quad 750. \quad 750. \quad -765.466 \quad -688.919 \quad -612.372 \quad -688.919 \quad 4.77396 \times 10^{-15} \quad 59.292$$

Natural boundary conditions

Specified NBC values for side 3: $\alpha = -55$ $\beta = 1100$

Interpolation functions for mapping: $\left\{0, 0, \frac{1-a}{2}, \frac{a+1}{2}\right\}$

Interpolation functions for solution:

$$\left\{0, 0, \frac{1-a}{2}, \frac{a+1}{2}, 0, 0, \frac{\frac{3a^2}{2} - \frac{3}{2}}{\sqrt{6}}, 0, 0, 0, \frac{\frac{5a}{2} - \frac{5a^3}{2}}{\sqrt{10}}, 0, 0, 0, \frac{\frac{35a^4}{8} - \frac{21a^2}{4} + \frac{7}{8}}{\sqrt{14}}, 0, 0\right\}$$

$$x(a) = 0.045 - 0.015a \quad y(a) = 0.015$$

$$J_c = 0.015$$

Value in mapped coordinate: $\alpha(a) = -55$ $\beta(a) = 1100$

Gauss point = -0.861136 Weight = 0.347855

$$\mathbf{N}_c^T = \{0., 0., 0.930568, 0.0694318, 0., 0., -0.158264, 0., 0., 0., -0.175946, 0., 0., 0., -0.163653, 0., 0.\}$$

$$J_c = 0.015 \quad \alpha = -55. \quad \beta = 1100.$$

$$\mathbf{k}_\alpha = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & -0.248513 & -0.0185421 & 0. & 0. & 0.0422652 & 0. & 0. & 0. & 0.0469871 & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & -0.0185421 & -0.00138347 & 0. & 0. & 0.0031535 & 0. & 0. & 0. & 0.00350582 & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0.0422652 & 0.0031535 & 0. & 0. & -0.00718815 & 0. & 0. & 0. & -0.00799122 & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0.0469871 & 0.00350582 & 0. & 0. & -0.00799122 & 0. & 0. & 0. & -0.00888402 & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0.0437043 & 0.00326088 & 0. & 0. & -0.00743291 & 0. & 0. & 0. & -0.00826333 & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

Gauss point = -0.339981 Weight = 0.652145

$$\mathbf{N}_c^T = \{0., 0., 0.669991, 0.330009, 0., 0., -0.54159, 0., 0., 0., -0.237711, 0., 0., 0., 0.0872927, 0., 0.\}$$

$$J_c = 0.015 \quad \alpha = -55. \quad \beta = 1100.$$

Gauss point = 0.339981 Weight = 0.652145

$$\mathbf{N}_c^T = \{0., 0., 0.330009, 0.669991, 0., 0., -0.54159, 0., 0., 0., 0.237711, 0., 0., 0., 0.0872927, 0., 0.\}$$

$\mathbf{J}_c = 0.015$ $\alpha = -55.$ $\beta = 1100.$

[illegible]

Gauss point = 0.861136

Weight = 0.347855

$$\mathbf{N}_c^T = \{0., 0., 0.0694318, 0.930568, 0., 0., -0.158264, 0., 0., 0., 0.175946, 0., 0., 0., -0.163653, 0., 0.\}$$

$$J_c = 0.015$$

$$\alpha = -55.$$

$$\beta = 1100.$$

$$\mathbf{k}_\alpha = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & -0.00138347 & -0.0185421 & 0. & 0. & 0.0031535 & 0. & 0. & 0. & -0.00350582 & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & -0.0185421 & -0.248513 & 0. & 0. & 0.0422652 & 0. & 0. & 0. & -0.0469871 & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0.0031535 & 0.0422652 & 0. & 0. & -0.00718815 & 0. & 0. & 0. & 0.00799122 & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & -0.00350582 & -0.0469871 & 0. & 0. & 0.00799122 & 0. & 0. & 0. & -0.00888402 & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0.00326088 & 0.0437043 & 0. & 0. & -0.00743291 & 0. & 0. & 0. & 0.00826333 & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix} -$$

Adding contributions from all Gauss points

$$k_\alpha = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & -0.55 & -0.275 & 0. & 0. & 0.336805 & 0. & 0. & 0.0869626 \\ 0. & 0. & -0.275 & -0.55 & 0. & 0. & 0.336805 & 0. & 0. & -0.0869626 \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0.336805 & 0.336805 & 0. & 0. & -0.33 & 0. & 0. & 3.46945 \times 10^{-18} \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0.0869626 & -0.0869626 & 0. & 0. & 3.46945 \times 10^{-18} & 0. & 0. & -0.0785714 \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 4.77049 \times 10^{-18} & 6.93889 \times 10^{-18} & 0. & 0. & 0.036006 & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\begin{pmatrix} 25.1402 & 19.8598 & -5.96963 & -39.0304 & -29.6457 & -5.43695 & 4.17787 & 5.43695 \\ 19.8598 & 70.1402 & -39.0304 & -50.9696 & -43.839 & 5.43695 & 32.5645 & 31.3054 \\ -5.96963 & -39.0304 & 43.7607 & 0.414252 & 14.1933 & -20.0595 & -28.0498 & -16.6829 \\ -39.0304 & -50.9696 & 0.414252 & 88.7607 & 59.2914 & 20.0595 & -8.01893 & -20.0595 \\ -29.6457 & -43.839 & 14.1933 & 59.2914 & 58.5981 & 4.76636 & -13.6963 & -34.7664 \\ -5.43695 & 5.43695 & -20.0595 & 20.0595 & 4.76636 & 97.1145 & 5.46729 & 37.8855 \\ 4.17787 & 32.5645 & -28.0498 & -8.01893 & -13.6963 & 5.46729 & 49.5625 & 24.5327 \\ 5.43695 & 31.3054 & -16.6829 & -20.0595 & -34.7664 & 37.8855 & 24.5327 & 97.1145 \\ 7.65449 & -7.65449 & 15.309 & -15.309 & -8.97663 & -8.97663 & -16.9036 & 8.97663 \\ -1.29299 & 1.29299 & -2.58597 & 2.58597 & -0.904903 & -15.0485 & 1.80981 & 3.42958 \\ -1.07872 & 1.07872 & -2.07048 & 2.07048 & 6.33432 & 6.33432 & -12.6686 & -6.33432 \\ 1.29299 & -1.29299 & 2.58597 & -2.58597 & 0.904903 & -19.8083 & -1.80981 & -15.0485 \\ 0 & 0 & 0 & 0 & -1.65193 & 0 & 9.19574 & 0 \\ -0.152988 & 0.152988 & -0.305977 & 0.305977 & -0.10707 & -0.749487 & 0.214139 & 0.749487 \\ 0 & 0 & 0 & 0 & -0.624062 & 0 & 1.28413 & 0 \\ 0.152988 & -0.152988 & 0.305977 & -0.305977 & 0.10707 & 0.749487 & -0.214139 & -0.749487 \\ 10.2336 & -10.2336 & 20.4673 & -20.4673 & -7.82921 & -60.0926 & -24.7582 & -50.1344 \end{pmatrix}$$

Equations for element 2

Element coordinates: ({0, 0} {0.03, 0.015} {0.03, 0.03} {0, 0.03})

$$x(s,t) = 0.015s + 0.015$$

$$y(s,t) = -0.00375ts + 0.00375s + 0.01125t + 0.01875$$

$$\mathbf{J} = \begin{pmatrix} 0.015 & 0 \\ 0.00375 - 0.00375t & 0.01125 - 0.00375s \end{pmatrix}$$

$$\det \mathbf{J} = 0.00016875 - 0.00005625s$$

Given element data

$$k_x = 45 \quad k_y = 45 \quad p = 0 \quad q = 5000000$$

Element data in mapped coordinates

$$k_x = 45 \quad k_y = 45 \quad p = 0 \quad q = 5000000$$

$$\text{Gauss point} = \{s \rightarrow -0.861136, t \rightarrow -0.861136\} \quad \text{Weight} = 0.121003$$

$$\mathbf{N}^T = \{0.865957, 0.0646111, 0.00482078, 0.0646111, -0.147276, -0.0109886, -0.0109886, -0.147276, 0.16373, 0.0122162, 0.0122162, 0.16373, -0.15229, -0.0113627, -0.0113627, -0.15229, 0.0250475\}$$

$$\partial \mathbf{N}^T / \partial s = (-0.465284 \quad 0.465284 \quad 0.0347159 \quad -0.0347159 \quad -0.981444 \quad -0.0791321 \quad -0.0732278 \quad 0.0732278 \quad -0.465284 \quad 0.465284 \quad 0.0347159 \quad -0.0347159 \quad -0.981444 \quad -0.0791321 \quad -0.0732278 \quad 0.0732278)$$

$$\partial \mathbf{N}^T / \partial t = (-0.465284 \quad -0.0347159 \quad 0.0347159 \quad 0.465284 \quad 0.0791321 \quad -0.0732278 \quad -0.0791321 \quad 0.0732278 \quad -0.465284 \quad -0.0347159 \quad 0.0347159 \quad 0.465284 \quad 0.0791321 \quad -0.0732278 \quad -0.0791321 \quad 0.0732278)$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 66.6667 & -32.1345 \\ 0. & 69.0643 \end{pmatrix} \quad \det \mathbf{J} = 0.000217189$$

$$\mathbf{B}^T = \begin{pmatrix} -16.0673 & 32.1345 & 1.19882 & -17.2661 & -67.9725 & -2.92233 & -2.33899 & 36.8137 & 62.89 \\ -32.1345 & -2.39763 & 2.39763 & 32.1345 & 5.4652 & -5.05743 & -5.4652 & -67.7828 & -6.07 \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$k_k = \begin{pmatrix} 1.52651 & -0.519487 & -0.113897 & -0.893127 & 1.08389 & 0.247726 & 0.252138 \\ -0.519487 & 1.22801 & 0.0387601 & -0.74728 & -2.59866 & -0.096717 & -0.073392 \\ -0.113897 & 0.0387601 & 0.00849808 & 0.0666383 & -0.0808712 & -0.0184834 & -0.0188126 \\ -0.893127 & -0.74728 & 0.0666383 & 1.57377 & 1.59564 & -0.132526 & -0.159934 \\ 1.08389 & -2.59866 & -0.0808712 & 1.59564 & 5.49935 & 0.202226 & 0.152698 \\ 0.247726 & -0.096717 & -0.0184834 & -0.132526 & 0.202226 & 0.0403483 & 0.0407711 \\ 0.252138 & -0.073392 & -0.0188126 & -0.159934 & 0.152698 & 0.0407711 & 0.041793 \\ 1.87643 & 1.59123 & -0.140005 & -3.32766 & -3.3974 & 0.278182 & 0.336267 \\ -0.964127 & 2.40728 & 0.0719358 & -1.51509 & -5.09482 & -0.181013 & -0.134696 \\ -0.246831 & 0.127625 & 0.0184166 & 0.10079 & -0.267797 & -0.0405716 & -0.0402547 \\ -0.262337 & 0.0456503 & 0.0195736 & 0.197113 & -0.0937334 & -0.0420576 & -0.0438462 \\ -1.70314 & -1.49958 & 0.127075 & 3.07564 & 3.20095 & -0.251838 & -0.305864 \\ 0.507274 & -1.4601 & -0.0378489 & 0.990679 & 3.09111 & 0.0975248 & 0.0685848 \\ 0.183381 & -0.151217 & -0.0136825 & -0.0184824 & 0.318588 & 0.0308083 & 0.029241 \\ 0.214948 & 0.0156611 & -0.0160377 & -0.214571 & -0.0357579 & 0.0338336 & 0.0365523 \\ 0.964886 & 0.959113 & -0.0719924 & -1.85201 & -2.04582 & 0.141381 & 0.174576 \\ -0.547623 & 0.186362 & 0.0408594 & 0.320402 & -0.388835 & -0.0888697 & -0.0904525 \end{pmatrix}$$

$$k_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$r_q^T = (113.789 \quad 8.49006 \quad 0.633463 \quad 8.49006 \quad -19.3524 \quad -1.44393 \quad -1.44393 \quad -19.3524 \quad 21.5145 \quad 1)$$

Gauss point = {s → -0.861136, t → -0.339981}

Weight = 0.226852

$$\mathbf{N}^T = \{0.623472, 0.0465187, 0.0229132, 0.307096, -0.106035, -0.0376036, -0.0522287, -0.503986, \\ 0.117882, 0.0165047, 0.0580638, 0.221207, -0.109646, 0.00606089, -0.0540071, 0.0812318, 0.0857143\}$$

$$\partial \mathbf{N}^T / \partial s = (-0.334995 \quad 0.334995 \quad 0.165005 \quad -0.165005 \quad -0.70662 \quad -0.270795 \quad -0.348052 \quad 0.270795)$$

$$\partial \mathbf{N}^T / \partial t = (-0.465284 \quad -0.0347159 \quad 0.0347159 \quad 0.465284 \quad 0.0791321 \quad -0.0289107 \quad -0.0791321 \quad -0.$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 66.6667 & -23.1362 \\ 0. & 69.0643 \end{pmatrix} \quad \det \mathbf{J} = 0.000217189$$

$$\mathbf{B}^T = \begin{pmatrix} -11.5681 & 23.1362 & 10.1971 & -21.7652 & -48.9388 & -17.3841 & -21.3726 & 27.0178 & 45.2 \\ -32.1345 & -2.39763 & 2.39763 & 32.1345 & 5.4652 & -1.9967 & -5.4652 & -26.761 & -6.0 \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$\mathbf{k}_k = \begin{pmatrix} 2.58618 & -0.422576 & -0.43236 & -1.73124 & 0.86581 & 0.588127 & 0.937544 & 1. \\ -0.422576 & 1.19954 & 0.510328 & -1.2873 & -2.53943 & -0.881124 & -1.06728 & 1. \\ -0.43236 & 0.510328 & 0.243286 & -0.321254 & -1.07738 & -0.403642 & -0.512254 & 0. \\ -1.73124 & -1.2873 & -0.321254 & 3.33979 & 2.75099 & 0.696638 & 0.641991 & -3. \\ 0.86581 & -2.53943 & -1.07738 & 2.75099 & 5.37629 & 1.86205 & 2.2528 & -3. \\ 0.588127 & -0.881124 & -0.403642 & 0.696638 & 1.86205 & 0.678875 & 0.847959 & -0. \\ 0.937544 & -1.06728 & -0.512254 & 0.641991 & 2.2528 & 0.847959 & 1.07899 & -0. \\ 1.21368 & 1.52817 & 0.468572 & -3.21041 & -3.25581 & -0.922877 & -0.956002 & 3. \\ -0.728474 & 2.355 & 0.991418 & -2.61795 & -4.98672 & -1.71834 & -2.07204 & 3. \\ -0.0480687 & 0.462175 & 0.184734 & -0.59884 & -0.979776 & -0.326415 & -0.384777 & 0. \\ -0.926997 & 0.955938 & 0.467856 & -0.496797 & -2.01674 & -0.769439 & -0.986528 & 0. \\ 2.28277 & 0.340325 & -0.104204 & -2.51889 & -0.748837 & 0.02379 & 0.250776 & 2. \\ 0.299059 & -1.43343 & -0.588492 & 1.72286 & 3.037 & 1.02946 & 1.22794 & -1. \\ -0.306054 & 0.0661526 & 0.0574453 & 0.182457 & -0.136706 & -0.0808109 & -0.124005 & -0. \\ 0.675789 & -0.516265 & -0.270822 & 0.111299 & 1.0871 & 0.435503 & 0.573141 & -0. \\ -3.02707 & -1.26311 & -0.177558 & 4.46773 & 2.71499 & 0.532186 & 0.323871 & -4. \\ -1.26184 & 1.85095 & 0.850652 & -1.43977 & -3.91126 & -1.4291 & -1.78736 & 1. \end{pmatrix}$$

$$\mathbf{k}_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_q^T = (153.591 \quad 11.4598 \quad 5.64463 \quad 75.6527 \quad -26.1217 \quad -9.26359 \quad -12.8665 \quad -124.156 \quad 29.0401 \quad 4.0)$$

$$\text{Gauss point} = \{s \rightarrow -0.861136, t \rightarrow 0.339981\} \quad \text{Weight} = 0.226852$$

$$\mathbf{N}^T = \{0.307096, 0.0229132, 0.0465187, 0.623472, -0.0522287, -0.0376036, -0.106035, -0.503986, 0.0580638, \\ -0.0165047, 0.117882, -0.221207, -0.0540071, 0.00606089, -0.109646, 0.0812318, 0.0857143\}$$

$$\partial \mathbf{N}^T / \partial s = (-0.165005 \quad 0.165005 \quad 0.334995 \quad -0.334995 \quad -0.348052 \quad -0.270795 \quad -0.70662 \quad 0.270795)$$

$$\partial \mathbf{N}^T / \partial t = (-0.465284 \quad -0.0347159 \quad 0.0347159 \quad 0.465284 \quad 0.0791321 \quad 0.0289107 \quad -0.0791321 \quad 0.387)$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 66.6667 & -11.3959 \\ 0. & 69.0643 \end{pmatrix} \quad \det \mathbf{J} = 0.000217189$$

$$\mathbf{B}^T = \begin{pmatrix} -5.69797 & 11.3959 & 21.9374 & -27.6354 & -24.1052 & -18.3825 & -46.2062 & 13.6373 & 22.30 \\ -32.1345 & -2.39763 & 2.39763 & 32.1345 & 5.4652 & 1.9967 & -5.4652 & 26.761 & -6.07 \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$k_k = \begin{pmatrix} 2.36146 & 0.0268562 & -0.447962 & -1.94035 & -0.0848514 & 0.0899709 & 0.973109 \\ 0.0268562 & 0.300679 & 0.541532 & -0.869068 & -0.638104 & -0.475072 & -1.13841 \\ -0.447962 & 0.541532 & 1.07974 & -1.17331 & -1.14338 & -0.883476 & -2.27644 \\ -1.94035 & -0.869068 & -1.17331 & 3.98273 & 1.86634 & 1.26858 & 2.44174 \\ -0.0848514 & -0.638104 & -1.14338 & 1.86634 & 1.35452 & 1.00664 & 2.40325 \\ 0.0899709 & -0.475072 & -0.883476 & 1.26858 & 1.00664 & 0.758043 & 1.85901 \\ 0.973109 & -1.13841 & -2.27644 & 2.44174 & 2.40325 & 1.85901 & 4.79985 \\ -2.07891 & 0.202307 & 0.805553 & 1.07105 & -0.404575 & -0.437339 & -1.72135 \\ 0.151119 & 0.595819 & 1.05249 & -1.79943 & -1.26561 & -0.935897 & -2.21124 \\ 0.271376 & -0.176715 & -0.378685 & 0.284023 & 0.371634 & 0.295325 & 0.799894 \\ -0.966535 & 1.03501 & 2.08689 & -2.15537 & -2.18401 & -1.69475 & -4.40117 \\ 2.19542 & 0.515013 & 0.47533 & -3.18577 & -1.11835 & -0.693081 & -0.970629 \\ -0.232395 & -0.370523 & -0.625392 & 1.22831 & 0.788681 & 0.57424 & 1.31205 \\ 0.218702 & 0.108553 & 0.151534 & -0.478789 & -0.23284 & -0.159783 & -0.315773 \\ 0.712564 & -0.589816 & -1.22328 & 1.10053 & 1.24268 & 0.974857 & 2.58177 \\ 3.46061 & 0.39603 & -0.00738451 & -3.84925 & -0.880905 & -0.433483 & 0.0611174 \\ -0.166293 & 1.00531 & 1.86448 & -2.70349 & -2.13046 & -1.60276 & -3.92291 \end{pmatrix}$$

$$k_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$r_q^T = (75.6527 \quad 5.64463 \quad 11.4598 \quad 153.591 \quad -12.8665 \quad -9.26359 \quad -26.1217 \quad -124.156 \quad 14.3039 \quad -4.121003)$$

Gauss point = {s → -0.861136, t → 0.861136}

Weight = 0.121003

$$\mathbf{N}^T = \{0.0646111, 0.00482078, 0.0646111, 0.865957, -0.0109886, -0.0109886, -0.147276, -0.147276, 0.0122162, -0.0122162, 0.16373, -0.16373, -0.0113627, -0.0113627, -0.15229, -0.15229, 0.0250475\}$$

$$\partial \mathbf{N}^T / \partial s = \begin{pmatrix} -0.0347159 & 0.0347159 & 0.465284 & -0.465284 & -0.0732278 & -0.0791321 & -0.981444 & 0.0 \end{pmatrix}$$

$$\partial \mathbf{N}^T / \partial t = \begin{pmatrix} -0.465284 & -0.0347159 & 0.0347159 & 0.465284 & 0.0791321 & 0.0732278 & -0.0791321 & 0.981 \end{pmatrix}$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 66.6667 & -2.39763 \\ 0. & 69.0643 \end{pmatrix} \quad \det \mathbf{J} = 0.000217189$$

$$\mathbf{B}^T = \begin{pmatrix} -1.19882 & 2.39763 & 30.9357 & -32.1345 & -5.07159 & -5.45104 & -65.2399 & 2.92233 & 4.6 \\ -32.1345 & -2.39763 & 2.39763 & 32.1345 & 5.4652 & 5.05743 & -5.4652 & 67.7828 & -6.0 \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$\mathbf{k}_k = \begin{pmatrix} 1.22291 & 0.087718 & -0.134976 & -1.17565 & -0.200504 & -0.184469 & 0.300188 & -; \\ 0.087718 & 0.0135969 & 0.0809195 & -0.182234 & -0.029877 & -0.0297967 & -0.169491 & -(\\ -0.134976 & 0.0809195 & 1.13859 & -1.08453 & -0.170049 & -0.185088 & -2.40232 & (\\ -1.17565 & -0.182234 & -1.08453 & 2.44242 & 0.40043 & 0.399354 & 2.27162 & ; \\ -0.200504 & -0.029877 & -0.170049 & 0.40043 & 0.0657413 & 0.0653817 & 0.355971 & (\\ -0.184469 & -0.0297967 & -0.185088 & 0.399354 & 0.0653817 & 0.065389 & 0.387883 & (\\ 0.300188 & -0.169491 & -2.40232 & 2.27162 & 0.355971 & 0.387883 & 5.06886 & -(\\ -2.58009 & -0.183911 & 0.299112 & 2.46489 & 0.420571 & 0.386572 & -0.663568 & ! \\ 0.224245 & 0.0305333 & 0.154447 & -0.409225 & -0.0674137 & -0.0665895 & -0.322773 & -(\\ -0.167893 & -0.0302511 & -0.2073 & 0.405444 & 0.0661498 & 0.0666151 & 0.434927 & (\\ -0.315755 & 0.152485 & 2.20697 & -2.0437 & -0.319716 & -0.349506 & -4.65719 & (\\ -2.36996 & -0.165932 & 0.311973 & 2.22392 & 0.379953 & 0.348283 & -0.688004 & ! \\ -0.210747 & -0.0240634 & -0.0877023 & 0.322512 & 0.0535307 & 0.0520777 & 0.182222 & (\\ -0.0960287 & -0.023489 & -0.195297 & 0.314814 & 0.0509578 & 0.05213 & 0.410537 & (\\ 0.264633 & -0.0837098 & -1.30285 & 1.12193 & 0.174436 & 0.192946 & 2.7503 & -(\\ -1.39842 & -0.0920362 & 0.256935 & 1.23353 & 0.211736 & 0.192189 & -0.559565 & ; \\ 0.421755 & 0.0653751 & 0.389067 & -0.876197 & -0.143651 & -0.143265 & -0.814924 & -(\end{pmatrix}$$

$$\mathbf{k}_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_q^T = (8.49006 \quad 0.633463 \quad 8.49006 \quad 113.789 \quad -1.44393 \quad -1.44393 \quad -19.3524 \quad -19.3524 \quad 1.60524 \quad -$$

$$\text{Gauss point} = \{s \rightarrow -0.339981, t \rightarrow -0.861136\} \quad \text{Weight} = 0.226852$$

$$\mathbf{N}^T = \{0.623472, 0.307096, 0.0229132, 0.0465187, -0.503986, -0.0522287, -0.0376036, -0.106035, \\ 0.221207, 0.0580638, 0.0165047, 0.117882, 0.0812318, -0.0540071, 0.00606089, -0.109646, 0.0857143\}$$

$$\partial \mathbf{N}^T / \partial s = (-0.465284 \quad 0.465284 \quad 0.0347159 \quad -0.0347159 \quad -0.387479 \quad -0.0791321 \quad -0.0289107 \quad 0.0$$

$$\partial \mathbf{N}^T / \partial t = (-0.334995 \quad -0.165005 \quad 0.165005 \quad 0.334995 \quad 0.270795 \quad -0.348052 \quad -0.270795 \quad -0.70662$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 66.6667 & -37.1486 \\ 0. & 79.8408 \end{pmatrix} \quad \det \mathbf{J} = 0.000187874$$

$$\mathbf{B}^T = \begin{pmatrix} -18.5743 & 37.1486 & -3.81531 & -14.759 & -35.8916 & 7.65418 & 8.13229 & 31.5255 & -2 \\ -26.7463 & -13.1741 & 13.1741 & 26.7463 & 21.6205 & -27.7887 & -21.6205 & -56.4171 & - \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$k_k = \begin{pmatrix} 2.03366 & -0.647577 & -0.539867 & -0.846216 & 0.169531 & 1.15279 & 0.819349 & 1. \\ -0.647577 & 2.97958 & -0.604689 & -1.72731 & -3.10343 & 1.24745 & 1.12567 & 3. \\ -0.539867 & -0.604689 & 0.360779 & 0.783777 & 0.808901 & -0.758128 & -0.605777 & -1. \\ -0.846216 & -1.72731 & 0.783777 & 1.78975 & 2.125 & -1.64211 & -1.33924 & -3. \\ 0.169531 & -3.10343 & 0.808901 & 2.125 & 3.36713 & -1.67916 & -1.4563 & -4. \\ 1.15279 & 1.24745 & -0.758128 & -1.64211 & -1.67916 & 1.59337 & 1.27165 & 3. \\ 0.819349 & 1.12567 & -0.605777 & -1.33924 & -1.4563 & 1.27165 & 1.02334 & 2. \\ 1.77094 & 3.67154 & -1.65614 & -3.78634 & -4.50944 & 3.46956 & 2.83106 & 8. \\ 1.4708 & -1.72827 & -0.0376404 & 0.295119 & 1.50796 & 0.100249 & -0.0373399 & -0. \\ -1.09466 & -1.07234 & 0.68848 & 1.47852 & 1.47111 & -1.44771 & -1.15143 & -3. \\ -0.244332 & -0.724654 & 0.289566 & 0.67942 & 0.861969 & -0.605656 & -0.499636 & -1. \\ -1.58931 & -3.44327 & 1.5278 & 3.50477 & 4.21 & -3.20005 & -2.61484 & -7. \\ -1.5813 & 3.60816 & -0.449576 & -1.57728 & -3.5455 & 0.911014 & 0.915093 & 3. \\ 0.715907 & 0.488865 & -0.390776 & -0.813996 & -0.728508 & 0.823122 & 0.646821 & 1. \\ -0.248007 & 0.0504583 & 0.0738221 & 0.123727 & 0.0106785 & -0.157184 & -0.114177 & -0. \\ 0.864587 & 2.17022 & -0.914315 & -2.12049 & -2.61689 & 1.91377 & 1.571 & 4. \\ -1.73997 & -2.35107 & 1.27539 & 2.81564 & 3.04927 & -2.67754 & -2.15347 & -5. \end{pmatrix}$$

$$k_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$r_q^T = (132.86 \quad 65.4415 \quad 4.88274 \quad 9.91303 \quad -107.398 \quad -11.1298 \quad -8.01324 \quad -22.5959 \quad 47.1386 \quad 12.$$

Gauss point = {s → -0.339981, t → -0.339981}

Weight = 0.425293

$$\mathbf{N}^T = \{0.448887, 0.221103, 0.108906, 0.221103, -0.36286, -0.17873, -0.17873, -0.36286, \\ 0.159264, 0.078447, 0.078447, 0.159264, 0.0584853, 0.0288074, 0.0288074, 0.0584853, 0.29332\}$$

$$\partial \mathbf{N}^T / \partial s = (-0.334995 \quad 0.334995 \quad 0.165005 \quad -0.165005 \quad -0.278977 \quad -0.270795 \quad -0.137413 \quad 0.270795)$$

$$\partial \mathbf{N}^T / \partial t = (-0.334995 \quad -0.165005 \quad 0.165005 \quad 0.334995 \quad 0.270795 \quad -0.137413 \quad -0.270795 \quad -0.278977)$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 66.6667 & -26.7463 \\ 0. & 79.8408 \end{pmatrix} \quad \det \mathbf{J} = 0.000187874$$

$$\mathbf{B}^T = \begin{pmatrix} -13.3731 & 26.7463 & 6.58705 & -19.9602 & -25.8413 & -14.3777 & -1.91808 & 25.5146 & -19.9602 \\ -26.7463 & -13.1741 & 13.1741 & 26.7463 & 21.6205 & -10.9711 & -21.6205 & -22.2738 & -9.9602 \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$\mathbf{k}_k = \begin{pmatrix} 3.21517 & -0.0191408 & -1.58366 & -1.61237 & -0.836649 & 1.74641 & 2.17143 \\ -0.0191408 & 3.19617 & 0.00942794 & -3.18646 & -3.50923 & -0.862993 & 0.839669 \\ -1.58366 & 0.00942794 & 0.780045 & 0.794187 & 0.412098 & -0.86021 & -1.06956 \\ -1.61237 & -3.18646 & 0.794187 & 4.00465 & 3.93378 & -0.0232088 & -1.94154 \\ -0.836649 & -3.50923 & 0.412098 & 3.93378 & 4.08175 & 0.483019 & -1.50252 \\ 1.74641 & -0.862993 & -0.86021 & -0.0232088 & 0.483019 & 1.17606 & 0.952031 \\ 2.17143 & 0.839669 & -1.06956 & -1.94154 & -1.50252 & 0.952031 & 1.69396 \\ 0.91518 & 3.50876 & -0.45078 & -3.97316 & -4.10218 & -0.440362 & 1.55555 \\ 1.86888 & -1.46308 & -0.920534 & 0.514734 & 1.11017 & 1.40247 & 0.874856 \\ 0.708376 & 1.84491 & -0.348917 & -2.20437 & -2.21753 & -0.108508 & 0.971698 \\ -0.213412 & -1.84786 & 0.105118 & 1.95615 & 2.08873 & 0.377362 & -0.637414 \\ 2.59268 & 1.43652 & -1.27705 & -2.75216 & -2.27116 & 1.02096 & 2.13835 \\ -1.37534 & 3.586 & 0.677436 & -2.88809 & -3.57607 & -1.70149 & 0.0255692 \\ -1.76476 & -1.33536 & 0.869247 & 2.23087 & 1.93906 & -0.599548 & -1.55089 \\ -1.09385 & 1.35238 & 0.538783 & -0.797316 & -1.1952 & -0.953183 & -0.37972 \\ -3.15887 & -3.559 & 1.55593 & 5.16195 & 4.75596 & -0.761398 & -3.08784 \\ -2.1644 & 0.0128852 & 1.06609 & 1.08542 & 0.563217 & -1.17565 & -1.46177 \end{pmatrix}$$

$$\mathbf{k}_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_q^T = (179.334 \quad 88.3324 \quad 43.5089 \quad 88.3324 \quad -144.965 \quad -71.4039 \quad -71.4039 \quad -144.965 \quad 63.6273 \quad 31)$$

$$\text{Gauss point} = \{s \rightarrow -0.339981, t \rightarrow 0.339981\} \quad \text{Weight} = 0.425293$$

$$\mathbf{N}^T = \{0.221103, 0.108906, 0.221103, 0.448887, -0.17873, -0.17873, -0.36286, -0.36286, 0.078447, -0.078447, 0.159264, -0.159264, 0.0288074, 0.0288074, 0.0584853, 0.0584853, 0.29332\}$$

$$\partial \mathbf{N}^T / \partial s = (-0.165005 \quad 0.165005 \quad 0.334995 \quad -0.334995 \quad -0.137413 \quad -0.270795 \quad -0.278977 \quad 0.270795)$$

$$\partial \mathbf{N}^T / \partial t = (-0.334995 \quad -0.165005 \quad 0.165005 \quad 0.334995 \quad 0.270795 \quad 0.137413 \quad -0.270795 \quad 0.278977)$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 66.6667 & -13.1741 \\ 0. & 79.8408 \end{pmatrix} \quad \det \mathbf{J} = 0.000187874$$

$$\mathbf{B}^T = \begin{pmatrix} -6.58705 & 13.1741 & 20.1592 & -26.7463 & -12.7283 & -19.8633 & -15.031 & 14.3777 & -9.795 \\ -26.7463 & -13.1741 & 13.1741 & 26.7463 & 21.6205 & 10.9711 & -21.6205 & 22.2738 & -9.489 \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$k_k = \begin{pmatrix} 2.72815 & 0.95491 & -1.74438 & -1.93867 & -1.77774 & -0.584627 & 2.4352 & -2.4 \\ 0.95491 & 1.24807 & 0.330874 & -2.53386 & -1.62705 & -1.46058 & 0.312133 & -0.3 \\ -1.74438 & 0.330874 & 2.08526 & -0.671746 & 0.101529 & -0.920084 & -2.11363 & 2.0 \\ -1.93867 & -2.53386 & -0.671746 & 5.14428 & 3.30326 & 2.96529 & -0.633697 & 0.7 \\ -1.77774 & -1.62705 & 0.101529 & 3.30326 & 2.26325 & 1.76193 & -0.992829 & 1.0 \\ -0.584627 & -1.46058 & -0.920084 & 2.96529 & 1.76193 & 1.85142 & 0.220639 & -0.1 \\ 2.4352 & 0.312133 & -2.11363 & -0.633697 & -0.992829 & 0.220639 & 2.49308 & -2.5 \\ -2.48255 & -0.374023 & 2.09723 & 0.759348 & 1.07351 & -0.148211 & -2.50856 & 2.5 \\ 1.1446 & -0.0145163 & -1.15955 & 0.0294712 & -0.289378 & 0.32529 & 1.26712 & -1.2 \\ 1.44305 & 0.375562 & -1.05614 & -0.762472 & -0.797903 & -0.131206 & 1.36468 & -1.3 \\ -0.329183 & -1.61632 & -1.33597 & 3.28147 & 1.86503 & 2.1336 & 0.59358 & -0.5 \\ 2.36104 & 1.89981 & -0.403818 & -3.85703 & -2.71877 & -1.98121 & 1.47294 & -1.5 \\ -0.0798599 & 0.995032 & 1.10496 & -2.02013 & -1.07278 & -1.38885 & -0.676051 & 0.6 \\ 1.80353 & 1.25781 & -0.50771 & -2.55364 & -1.86414 & -1.24758 & 1.23947 & -1.3 \\ -1.13636 & 1.43741 & 2.6172 & -2.91825 & -1.27735 & -2.27867 & -2.09924 & 2.0 \\ 3.87039 & 2.13598 & -1.66987 & -4.3365 & -3.38109 & -1.90314 & 2.99292 & -3.0 \\ 1.30508 & 1.70575 & 0.452207 & -3.46303 & -2.22369 & -1.99618 & 0.426593 & -0.5 \end{pmatrix}$$

$$k_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$r_q^T = (88.3324 \quad 43.5089 \quad 88.3324 \quad 179.334 \quad -71.4039 \quad -71.4039 \quad -144.965 \quad -144.965 \quad 31.3402 \quad -$$

Gauss point = {s → -0.339981, t → 0.861136}

Weight = 0.226852

$$\begin{aligned}
\mathbf{N}^T &= \\
&\{0.0465187, 0.0229132, 0.307096, 0.623472, -0.0376036, -0.0522287, -0.503986, -0.106035, 0.0165047, \\
&-0.0580638, 0.221207, -0.117882, 0.00606089, -0.0540071, 0.0812318, -0.109646, 0.0857143\} \\
\partial \mathbf{N}^T / \partial s &= (-0.0347159 \quad 0.0347159 \quad 0.465284 \quad -0.465284 \quad -0.0289107 \quad -0.0791321 \quad -0.387479 \quad 0.0 \\
\partial \mathbf{N}^T / \partial t &= (-0.334995 \quad -0.165005 \quad 0.165005 \quad 0.334995 \quad 0.270795 \quad 0.348052 \quad -0.270795 \quad 0.70662 \quad - \\
\mathbf{J}^{-T} &= \begin{pmatrix} 66.6667 & -2.77175 \\ 0. & 79.8408 \end{pmatrix} \quad \det \mathbf{J} = 0.000187874 \\
\mathbf{B}^T &= \begin{pmatrix} -1.38587 & 2.77175 & 30.5616 & -31.9475 & -2.67796 & -6.24018 & -25.0814 & 3.3169 & -2.0 \\ -26.7463 & -13.1741 & 13.1741 & 26.7463 & 21.6205 & 27.7887 & -21.6205 & 56.4171 & -9.4
\end{pmatrix} \\
k_x &= 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6 \\
\mathbf{k}_k &= \begin{pmatrix} 1.37566 & 0.668414 & -0.757012 & -1.28707 & -1.10193 & -1.40887 & 1.17571 & -2.90 \\ 0.668414 & 0.347596 & -0.1704 & -0.84561 & -0.560506 & -0.735292 & 0.412941 & -1.40 \\ -0.757012 & -0.1704 & 2.12418 & -1.19677 & 0.389306 & 0.336361 & -2.01638 & 1.61 \\ -1.28707 & -0.84561 & -1.19677 & 3.32945 & 1.27313 & 1.8078 & 0.427723 & 2.69 \\ -1.10193 & -0.560506 & 0.389306 & 1.27313 & 0.910258 & 1.18432 & -0.767686 & 2.32 \\ -1.40887 & -0.735292 & 0.336361 & 1.8078 & 1.18432 & 1.55569 & -0.852101 & 2.96 \\ 1.17571 & 0.412941 & -2.01638 & 0.427723 & -0.767686 & -0.852101 & 2.103 & -2.49 \\ -2.9028 & -1.40782 & 1.61987 & 2.69075 & 2.32233 & 2.96708 & -2.49892 & 6.12 \\ 0.492254 & 0.22881 & -0.360569 & -0.360495 & -0.382902 & -0.481082 & 0.492629 & -1.03 \\ -1.29062 & -0.680427 & 0.248875 & 1.72217 & 1.09245 & 1.44035 & -0.733064 & 2.71 \\ -0.400745 & -0.411828 & -1.65742 & 2.46999 & 0.559728 & 0.893122 & 1.1635 & 0.82 \\ -2.66747 & -1.28694 & 1.54694 & 2.40748 & 2.12664 & 2.71153 & -2.34316 & 5.62 \\ 0.168956 & 0.107644 & 0.128026 & -0.404626 & -0.163431 & -0.22984 & -0.0328303 & -0.35 \\ -0.75468 & -0.411319 & 0.0292392 & 1.13676 & 0.653586 & 0.872126 & -0.335397 & 1.58 \\ -0.305446 & 0.165335 & 2.88186 & -2.74175 & -0.100311 & -0.38473 & -2.43733 & 0.68 \\ -1.5761 & -0.747195 & 1.02825 & 1.29504 & 1.24202 & 1.57277 & -1.47608 & 3.32 \\ 2.32348 & 1.18404 & -0.801968 & -2.70555 & -1.92173 & -2.50207 & 1.60355 & -4.89
\end{pmatrix}
\end{aligned}$$

$$\mathbf{k}_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_q^T = (9.91303 \quad 4.88274 \quad 65.4415 \quad 132.86 \quad -8.01324 \quad -11.1298 \quad -107.398 \quad -22.5959 \quad 3.51712 \quad -11.1298)$$

$$\text{Gauss point} = \{s \rightarrow 0.339981, t \rightarrow -0.861136\} \quad \text{Weight} = 0.226852$$

$$\mathbf{N}^T = \{0.307096, 0.623472, 0.0465187, 0.0229132, -0.503986, -0.106035, -0.0376036, -0.0522287, -0.221207, 0.117882, -0.0165047, 0.0580638, 0.0812318, -0.109646, 0.00606089, -0.0540071, 0.0857143\}$$

$$\partial \mathbf{N}^T / \partial s = (-0.465284 \quad 0.465284 \quad 0.0347159 \quad -0.0347159 \quad 0.387479 \quad -0.0791321 \quad 0.0289107 \quad 0.0791321)$$

$$\partial \mathbf{N}^T / \partial t = (-0.165005 \quad -0.334995 \quad 0.334995 \quad 0.165005 \quad 0.270795 \quad -0.70662 \quad -0.270795 \quad -0.348052)$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 66.6667 & -46.6447 \\ 0. & 100.25 \end{pmatrix} \quad \det \mathbf{J} = 0.000149626$$

$$\mathbf{B}^T = \begin{pmatrix} -23.3223 & 46.6447 & -13.3114 & -10.011 & 13.2008 & 27.6846 & 14.5585 & 21.5102 & -37.5102 \\ -16.5417 & -33.5832 & 33.5832 & 16.5417 & 27.1472 & -70.8386 & -27.1472 & -34.8922 & 11.9078 \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$k_k = \begin{pmatrix} 1.24877 & -0.813112 & -0.374332 & -0.0613241 & -1.15617 & 0.803616 & 0.167287 & 0.11 \\ -0.813112 & 5.04597 & -2.67108 & -1.56178 & -0.452033 & 5.60618 & 2.42979 & 3.3 \\ -0.374332 & -2.67108 & 1.99334 & 1.05207 & 1.12414 & -4.19664 & -1.68855 & -2.2 \\ -0.0613241 & -1.56178 & 1.05207 & 0.571028 & 0.484055 & -2.21316 & -0.908526 & -1.2 \\ -1.15617 & -0.452033 & 1.12414 & 0.484055 & 1.39184 & -2.37914 & -0.832122 & -1.0 \\ 0.803616 & 5.60618 & -4.19664 & -2.21316 & -2.37914 & 8.83551 & 3.55299 & 4.6 \\ 0.167287 & 2.42979 & -1.68855 & -0.908526 & -0.832122 & 3.55299 & 1.44941 & 1.9 \\ 0.115332 & 3.32237 & -2.22718 & -1.21051 & -1.0131 & 4.68497 & 1.92515 & 2.5 \\ 1.03775 & -3.28881 & 1.37534 & 0.87573 & -0.263711 & -2.87846 & -1.3298 & -1.8 \\ -0.774123 & -5.07364 & 3.83172 & 2.01605 & 2.20465 & -8.06774 & -3.2389 & -4.2 \\ 0.188716 & 0.835886 & -0.675326 & -0.349276 & -0.430487 & 1.4226 & 0.564198 & 0.7 \\ -0.069467 & -3.12273 & 2.06532 & 1.12687 & 0.909417 & -4.344 & -1.79 & -2.3 \\ 1.74033 & -3.0351 & 0.705754 & 0.589018 & -1.10391 & -1.46117 & -0.835921 & -1.2 \\ 0.527153 & 2.84509 & -2.21567 & -1.15657 & -1.3386 & 4.66617 & 1.86277 & 2.4 \\ 0.0889829 & -0.623522 & 0.338335 & 0.196204 & 0.0684931 & -0.710298 & -0.305991 & -0.4 \\ -0.0303932 & 1.98147 & -1.25689 & -0.694181 & -0.495166 & 2.64266 & 1.09858 & 1.4 \\ -0.341189 & -5.14862 & 3.5684 & 1.92141 & 1.74862 & -7.50833 & -3.0646 & -4.0 \end{pmatrix}$$

$$k_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$r_q^T = (52.1188 \quad 105.812 \quad 7.89491 \quad 3.8887 \quad -85.5339 \quad -17.9958 \quad -6.38189 \quad -8.86397 \quad -37.542 \quad 20.0)$$

Gauss point = {s → 0.339981, t → -0.339981}

Weight = 0.425293

$$\mathbf{N}^T = \{0.221103, 0.448887, 0.221103, 0.108906, -0.36286, -0.36286, -0.17873, -0.17873, -0.159264, 0.159264, -0.078447, 0.078447, 0.0584853, 0.0584853, 0.0288074, 0.0288074, 0.29332\}$$

$$\partial \mathbf{N}^T / \partial s = \begin{pmatrix} -0.334995 & 0.334995 & 0.165005 & -0.165005 & 0.278977 & -0.270795 & 0.137413 & 0.270795 \end{pmatrix}$$

$$\partial \mathbf{N}^T / \partial t = \begin{pmatrix} -0.165005 & -0.334995 & 0.334995 & 0.165005 & 0.270795 & -0.278977 & -0.270795 & -0.13741 \end{pmatrix}$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 66.6667 & -33.5832 \\ 0. & 100.25 \end{pmatrix} \quad \det \mathbf{J} = 0.000149626$$

$$\mathbf{B}^T = \begin{pmatrix} -16.7916 & 33.5832 & -0.249912 & -16.5417 & 9.50432 & -8.68404 & 18.255 & 22.6678 & -2 \\ -16.5417 & -33.5832 & 33.5832 & 16.5417 & 27.1472 & -27.9675 & -27.1472 & -13.7756 & 1 \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$\mathbf{k}_k = \begin{pmatrix} 1.59096 & -0.0240336 & -1.57877 & 0.0118379 & -1.74292 & 1.74234 & 0.408143 & -0.4 \\ -0.0240336 & 6.45927 & -3.25367 & -3.18157 & -1.69668 & 1.85445 & 4.36624 & 3.5 \\ -1.57877 & -3.25367 & 3.22982 & 1.60262 & 2.60389 & -2.68336 & -2.62376 & -1.3 \\ 0.0118379 & -3.18157 & 1.60262 & 1.56711 & 0.835714 & -0.913425 & -2.15063 & -1.7 \\ -1.74292 & -1.69668 & 2.60389 & 0.835714 & 2.36904 & -2.41048 & -1.61353 & -0.4 \\ 1.74234 & 1.85445 & -2.68336 & -0.913425 & -2.41048 & 2.45578 & 1.72018 & 0.5 \\ 0.408143 & 4.36624 & -2.62376 & -2.15063 & -1.61353 & 1.72018 & 3.06464 & 2.2 \\ -0.437429 & 3.50469 & -1.341 & -1.72626 & -0.453954 & 0.539557 & 2.25584 & 2.0 \\ 0.736673 & -3.74803 & 1.16523 & 1.84612 & 0.189837 & -0.281383 & -2.34074 & -2.2 \\ 0.703323 & 5.21524 & -3.34975 & -2.56881 & -2.16458 & 2.29196 & 3.71812 & 2.6 \\ 0.918798 & 0.437087 & -1.14059 & -0.215291 & -1.12686 & 1.13753 & 0.540992 & -0.0 \\ 0.915098 & 1.43147 & -1.64148 & -0.705082 & -1.38806 & 1.42302 & 1.21316 & 0.5 \\ 1.79111 & -2.74692 & -0.397215 & 1.35302 & -1.23663 & 1.16954 & -1.38174 & -1.9 \\ -1.75722 & -6.36231 & 4.98572 & 3.13381 & 3.62938 & -3.78478 & -4.77578 & -2.9 \\ 0.678074 & -2.19146 & 0.433964 & 1.07942 & -0.160968 & 0.107441 & -1.30264 & -1.3 \\ -0.656706 & -3.55147 & 2.45887 & 1.7493 & 1.66948 & -1.75623 & -2.57938 & -1.7 \\ 0.016179 & -4.34827 & 2.19031 & 2.14177 & 1.14217 & -1.24838 & -2.93928 & -2.3 \end{pmatrix}$$

$$\mathbf{k}_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_q^T = (70.3495 \quad 142.825 \quad 70.3495 \quad 34.6512 \quad -115.453 \quad -115.453 \quad -56.8673 \quad -56.8673 \quad -50.6739 \quad)$$

$$\text{Gauss point} = \{s \rightarrow 0.339981, t \rightarrow 0.339981\} \quad \text{Weight} = 0.425293$$

$$\mathbf{N}^T = \{0.108906, 0.221103, 0.448887, 0.221103, -0.17873, -0.36286, -0.36286, -0.17873, -0.078447, \\ -0.159264, -0.159264, -0.078447, 0.0288074, 0.0584853, 0.0584853, 0.0288074, 0.29332\}$$

$$\partial \mathbf{N}^T / \partial s = (-0.165005 \quad 0.165005 \quad 0.334995 \quad -0.334995 \quad 0.137413 \quad -0.270795 \quad 0.278977 \quad 0.270795$$

$$\partial \mathbf{N}^T / \partial t = (-0.165005 \quad -0.334995 \quad 0.334995 \quad 0.165005 \quad 0.270795 \quad 0.278977 \quad -0.270795 \quad 0.137413$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 66.6667 & -16.5417 \\ 0. & 100.25 \end{pmatrix} \quad \det \mathbf{J} = 0.000149626$$

$$\mathbf{B}^T = \begin{pmatrix} -8.27086 & 16.5417 & 16.7916 & -25.0625 & 4.68143 & -22.6678 & 23.0779 & 15.78 & -13.32 \\ -16.5417 & -33.5832 & 33.5832 & 16.5417 & 27.1472 & 27.9675 & -27.1472 & 13.7756 & 11.91 \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$k_k = \begin{pmatrix} 0.979443 & 1.19901 & -1.98848 & -0.18997 & -1.39679 & -0.787906 & 0.739337 & -1.02626 \\ 1.19901 & 4.01319 & -2.43424 & -2.77795 & -2.38894 & -3.76331 & 3.70386 & -0.577302 \\ -1.98848 & -2.43424 & 4.03705 & 0.385679 & 2.83579 & 1.59962 & -1.50101 & 2.08354 \\ -0.18997 & -2.77795 & 0.385679 & 2.58224 & 0.94994 & 2.9516 & -2.94218 & -0.479972 \\ -1.39679 & -2.38894 & 2.83579 & 0.94994 & 2.17312 & 1.87026 & -1.80099 & 1.28243 \\ -0.787906 & -3.76331 & 1.59962 & 2.9516 & 1.87026 & 3.71121 & -3.67214 & 0.0789551 \\ 0.739337 & 3.70386 & -1.50101 & -2.94218 & -1.80099 & -3.67214 & 3.63548 & -0.0280642 \\ -1.02626 & -0.577302 & 2.08354 & -0.479972 & 1.28243 & 0.0789551 & -0.0280642 & 1.251045 \\ -0.248747 & -1.77719 & 0.50501 & 1.52093 & 0.7476 & 1.81938 & -1.80704 & -0.133861 \\ 1.69517 & 3.23154 & -3.44156 & -1.48515 & -2.72598 & -2.63514 & 2.55108 & -1.463869 \\ 1.06416 & 0.146356 & -2.16048 & 0.949962 & -1.20914 & 0.415415 & -0.468186 & -1.427167 \\ 0.554867 & 2.15193 & -1.1265 & -1.5803 & -1.18416 & -2.06564 & 2.03812 & -0.18259632 \\ 0.591527 & -0.347741 & -1.20093 & 0.957141 & -0.557645 & 0.702722 & -0.732055 & -0.90901 \\ 2.17957 & 5.5176 & -4.42501 & -3.27217 & -3.86844 & -4.88642 & 4.77834 & -1.52107683 \\ 0.624693 & -2.0847 & -1.26826 & 2.72827 & -0.130754 & 2.63055 & -2.66152 & -1.4107683 \\ 1.17643 & 2.51202 & -2.3884 & -1.30005 & -1.96365 & -2.12494 & 2.0666 & -0.9451045 \\ 1.33861 & 1.63869 & -2.71767 & -0.259632 & -1.90901 & -1.07683 & 1.01045 & -1.407683 \end{pmatrix}$$

$$k_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$r_q^T = (34.6512 \quad 70.3495 \quad 142.825 \quad 70.3495 \quad -56.8673 \quad -115.453 \quad -115.453 \quad -56.8673 \quad -24.9599)$$

Gauss point = {s → 0.339981, t → 0.861136}

Weight = 0.226852

$$\begin{aligned}
\mathbf{N}^T &= \\
&\{0.0229132, 0.0465187, 0.623472, 0.307096, -0.0376036, -0.106035, -0.503986, -0.0522287, -0.0165047, \\
&-0.117882, -0.221207, -0.0580638, 0.00606089, -0.109646, 0.0812318, -0.0540071, 0.0857143\} \\
\partial \mathbf{N}^T / \partial s &= (-0.0347159 \quad 0.0347159 \quad 0.465284 \quad -0.465284 \quad 0.0289107 \quad -0.0791321 \quad 0.387479 \quad 0.0791321) \\
\partial \mathbf{N}^T / \partial t &= (-0.165005 \quad -0.334995 \quad 0.334995 \quad 0.165005 \quad 0.270795 \quad 0.70662 \quad -0.270795 \quad 0.348052 \quad 0) \\
\mathbf{J}^{-T} &= \begin{pmatrix} 66.6667 & -3.48027 \\ 0. & 100.25 \end{pmatrix} \quad \det \mathbf{J} = 0.000149626 \\
\mathbf{B}^T &= \begin{pmatrix} -1.74013 & 3.48027 & 29.8531 & -31.5932 & 0.984943 & -7.7347 & 26.7744 & 4.06416 & -2.81 \\ -16.5417 & -33.5832 & 33.5832 & 16.5417 & 27.1472 & 70.8386 & -27.1472 & 34.8922 & 11.9 \end{pmatrix} \\
k_x &= 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6 \\
\mathbf{k}_k &= \begin{pmatrix} 0.422574 & 0.839276 & -0.927874 & -0.333976 & -0.688528 & -1.76928 & 0.614745 & -0.89 \\ 0.839276 & 1.74119 & -1.564 & -1.01647 & -1.38731 & -3.67487 & 1.53488 & -1.76 \\ -0.927874 & -1.564 & 3.08395 & -0.592078 & 1.43746 & 3.28106 & -0.171672 & 1.97 \\ -0.333976 & -1.01647 & -0.592078 & 1.94253 & 0.63838 & 2.16308 & -1.97795 & 0.68 \\ -0.688528 & -1.38731 & 1.43746 & 0.63838 & 1.12715 & 2.92572 & -1.08539 & 1.45 \\ -1.76928 & -3.67487 & 3.28106 & 2.16308 & 2.92572 & 7.75621 & -3.25368 & 3.72 \\ 0.614745 & 1.53488 & -0.171672 & -1.97795 & -1.08539 & -3.25368 & 2.22064 & -1.28 \\ -0.8924 & -1.76823 & 1.97515 & 0.685476 & 1.45294 & 3.72736 & -1.28061 & 1.88 \\ -0.293602 & -0.626114 & 0.483345 & 0.436371 & 0.489854 & 1.32238 & -0.608749 & 0.61 \\ -1.62147 & -3.37894 & 2.9654 & 2.03502 & 2.68426 & 7.13224 & -3.02866 & 3.41 \\ 0.385112 & 0.443095 & -2.05324 & 1.22504 & -0.54165 & -0.915626 & -0.79925 & -0.83 \\ -0.821936 & -1.61779 & 1.85978 & 0.579946 & 1.33533 & 3.40963 & -1.1338 & 1.73 \\ 0.119627 & 0.206303 & -0.3801 & 0.0541709 & -0.186569 & -0.433111 & 0.041834 & -0.25 \\ -0.949507 & -2.00038 & 1.65495 & 1.29494 & 1.57766 & 4.22357 & -1.86532 & 1.99 \\ 0.0168622 & -0.479281 & -1.96145 & 2.42387 & 0.109315 & 1.03979 & -2.14191 & -0.06 \\ -0.489329 & -0.942022 & 1.18643 & 0.244924 & 0.789337 & 1.98416 & -0.585802 & 1.03 \\ 1.45321 & 2.92457 & -3.04704 & -1.33075 & -2.37805 & -6.16748 & 2.27606 & -3.06 \end{pmatrix}
\end{aligned}$$

$$\mathbf{k}_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_q^T = (3.8887 \quad 7.89491 \quad 105.812 \quad 52.1188 \quad -6.38189 \quad -17.9958 \quad -85.5339 \quad -8.86397 \quad -2.8011 \quad -20.0000)$$

$$\text{Gauss point} = \{s \rightarrow 0.861136, t \rightarrow -0.861136\} \quad \text{Weight} = 0.121003$$

$$\mathbf{N}^T = \{0.0646111, 0.865957, 0.0646111, 0.00482078, -0.147276, -0.147276, -0.0109886, -0.0109886, -0.16373, 0.16373, -0.0122162, 0.0122162, -0.15229, -0.15229, -0.0113627, -0.0113627, 0.0250475\}$$

$$\partial \mathbf{N}^T / \partial s = (-0.465284 \quad 0.465284 \quad 0.0347159 \quad -0.0347159 \quad 0.981444 \quad -0.0791321 \quad 0.0732278 \quad 0.0791321 \quad -0.0347159 \quad 0.0347159 \quad -0.465284 \quad 0.465284 \quad -0.0791321 \quad 0.0791321 \quad -0.0113627 \quad 0.0113627 \quad -0.0250475)$$

$$\partial \mathbf{N}^T / \partial t = (-0.0347159 \quad -0.465284 \quad 0.465284 \quad 0.0347159 \quad 0.0791321 \quad -0.981444 \quad -0.0791321 \quad -0.0732278 \quad 0.0347159 \quad -0.0347159 \quad -0.0791321 \quad -0.465284 \quad 0.0791321 \quad 0.981444 \quad 0.0113627 \quad 0.0113627 \quad 0.0250475)$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 66.6667 & -58.0101 \\ 0. & 124.677 \end{pmatrix} \quad \det \mathbf{J} = 0.000120311$$

$$\mathbf{B}^T = \begin{pmatrix} -29.0051 & 58.0101 & -24.6768 & -4.32827 & 60.8392 & 51.6582 & 9.47232 & 9.52343 & 54.0000 \\ -4.32827 & -58.0101 & 58.0101 & 4.32827 & 9.86593 & -122.363 & -9.86593 & -9.12981 & 10.0000 \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$k_k = \begin{pmatrix} 0.563413 & -0.937793 & 0.304409 & 0.0699709 & -1.18401 & -0.634624 & -0.152014 & -0. \\ -0.937793 & 4.40912 & -3.14235 & -0.328975 & 1.93714 & 6.61335 & 0.734912 & 0. \\ 0.304409 & -3.14235 & 2.60349 & 0.234458 & -0.608592 & -5.48528 & -0.528065 & -0. \\ 0.0699709 & -0.328975 & 0.234458 & 0.0245456 & -0.144534 & -0.493437 & -0.0548335 & -0. \\ -1.18401 & 1.93714 & -0.608592 & -0.144534 & 2.48859 & 1.26804 & 0.313766 & 0. \\ -0.634624 & 6.61335 & -5.48528 & -0.493437 & 1.26804 & 11.557 & 1.11143 & 1. \\ -0.152014 & 0.734912 & -0.528065 & -0.0548335 & 0.313766 & 1.11143 & 0.122546 & 0. \\ -0.155072 & 0.708879 & -0.500916 & -0.0528911 & 0.320561 & 1.05415 & 0.118105 & 0. \\ -1.07544 & 1.67185 & -0.471673 & -0.124741 & 2.26143 & 0.980749 & 0.270164 & 0. \\ 0.563163 & -6.03218 & 5.01894 & 0.450075 & -1.12332 & -10.5747 & -1.01394 & -0. \\ -0.151026 & 0.781077 & -0.571772 & -0.0582779 & 0.311126 & 1.20359 & 0.130368 & 0. \\ 0.161775 & -0.689587 & 0.476361 & 0.0514517 & -0.335006 & -1.00229 & -0.114762 & -0. \\ -0.610808 & 0.776059 & -0.107348 & -0.0579036 & 1.28645 & 0.218537 & 0.12409 & 0. \\ -0.293595 & 3.47608 & -2.92312 & -0.259358 & 0.581713 & 6.15934 & 0.584656 & 0. \\ -0.111414 & 0.668384 & -0.5071 & -0.0498696 & 0.228433 & 1.06774 & 0.111769 & 0. \\ -0.133295 & 0.482136 & -0.312868 & -0.0359733 & 0.277046 & 0.657948 & 0.0799994 & 0. \\ 0.336425 & -1.58174 & 1.12729 & 0.118017 & -0.694932 & -2.37248 & -0.263644 & -0. \end{pmatrix}$$

$$k_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$r_q^T = (4.70304 \quad 63.033 \quad 4.70304 \quad 0.350905 \quad -10.7202 \quad -10.7202 \quad -0.799858 \quad -0.799858 \quad -11.9179)$$

Gauss point = {s → 0.861136, t → -0.339981}

Weight = 0.226852

$$\begin{aligned}
\mathbf{N}^T &= \\
&\{0.0465187, 0.623472, 0.307096, 0.0229132, -0.106035, -0.503986, -0.0522287, -0.0376036, -0.117882, \\
&0.221207, -0.0580638, 0.0165047, -0.109646, 0.0812318, -0.0540071, 0.00606089, 0.0857143\} \\
\partial \mathbf{N}^T / \partial s &= (-0.334995 \quad 0.334995 \quad 0.165005 \quad -0.165005 \quad 0.70662 \quad -0.270795 \quad 0.348052 \quad 0.270795 \quad 0 \\
\partial \mathbf{N}^T / \partial t &= (-0.0347159 \quad -0.465284 \quad 0.465284 \quad 0.0347159 \quad 0.0791321 \quad -0.387479 \quad -0.0791321 \quad -0.0 \\
\mathbf{J}^{-T} &= \begin{pmatrix} 66.6667 & -41.7661 \\ 0. & 124.677 \end{pmatrix} \quad \det \mathbf{J} = 0.000120311 \\
\mathbf{B}^T &= \begin{pmatrix} -20.8831 & 41.7661 & -8.4328 & -12.4503 & 43.803 & -1.86949 & 26.5085 & 19.2605 & 39.5 \\ -4.32827 & -58.0101 & 58.0101 & 4.32827 & 9.86593 & -48.3097 & -9.86593 & -3.6045 & 10.9 \end{pmatrix} \\
k_x &= 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6 \\
\mathbf{k}_k &= \begin{pmatrix} 0.558619 & -0.762846 & -0.0920895 & 0.296317 & -1.17591 & 0.304757 & -0.627446 & -0. \\ -0.762846 & 6.27547 & -4.5656 & -0.947025 & 1.54401 & 3.346 & 2.0627 & 1. \\ -0.0920895 & -4.5656 & 4.22036 & 0.437322 & 0.249249 & -3.42254 & -0.977462 & -0. \\ 0.296317 & -0.947025 & 0.437322 & 0.213387 & -0.61735 & -0.228222 & -0.457791 & -0. \\ -1.17591 & 1.54401 & 0.249249 & -0.61735 & 2.47605 & -0.685947 & 1.30655 & 0. \\ 0.304757 & 3.346 & -3.42254 & -0.228222 & -0.685947 & 2.87064 & 0.524508 & 0. \\ -0.627446 & 2.0627 & -0.977462 & -0.457791 & 1.30655 & 0.524508 & 0.982586 & 0. \\ -0.474833 & 1.2448 & -0.456288 & -0.313675 & 0.992495 & 0.169642 & 0.670742 & 0. \\ -1.07322 & 1.24838 & 0.371614 & -0.546774 & 2.26172 & -0.741629 & 1.1554 & 0. \\ -0.39952 & 5.7049 & -4.55879 & -0.746589 & 0.780078 & 3.49073 & 1.63746 & 0. \\ -0.582254 & 2.06256 & -1.04011 & -0.4402 & 1.21069 & 0.593428 & 0.946014 & 0. \\ 0.188582 & -0.0111267 & -0.251953 & 0.0744978 & -0.39988 & 0.280002 & -0.155046 & -0. \\ -0.619717 & 0.404121 & 0.4985 & -0.282904 & 1.30974 & -0.655928 & 0.594197 & 0. \\ 0.218147 & -7.75354 & 6.64704 & 0.888351 & -0.371166 & -5.24035 & -1.96282 & -1. \\ -0.355132 & 1.54558 & -0.892154 & -0.29829 & 0.735037 & 0.568658 & 0.643254 & 0. \\ 0.0964744 & -0.738905 & 0.528336 & 0.114095 & -0.195912 & -0.383815 & -0.248252 & -0. \\ 1.0036 & -2.67992 & 1.00827 & 0.668049 & -2.09713 & -0.393733 & -1.42894 & -1. \end{pmatrix}
\end{aligned}$$

$$\mathbf{k}_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_q^T = (6.34812 \quad 85.0814 \quad 41.9076 \quad 3.12682 \quad -14.47 \quad -68.776 \quad -7.12733 \quad -5.13154 \quad -16.0866 \quad 30.1$$

$$\text{Gauss point} = \{s \rightarrow 0.861136, t \rightarrow 0.339981\} \quad \text{Weight} = 0.226852$$

$$\mathbf{N}^T = \{0.0229132, 0.307096, 0.623472, 0.0465187, -0.0522287, -0.503986, -0.106035, -0.0376036, -0.0580638, \\ -0.221207, -0.117882, -0.0165047, -0.0540071, 0.0812318, -0.109646, 0.00606089, 0.0857143\}$$

$$\partial \mathbf{N}^T / \partial s = (-0.165005 \quad 0.165005 \quad 0.334995 \quad -0.334995 \quad 0.348052 \quad -0.270795 \quad 0.70662 \quad 0.270795 \quad 0$$

$$\partial \mathbf{N}^T / \partial t = (-0.0347159 \quad -0.465284 \quad 0.465284 \quad 0.0347159 \quad 0.0791321 \quad 0.387479 \quad -0.0791321 \quad 0.0289$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 66.6667 & -20.5723 \\ 0. & 124.677 \end{pmatrix} \quad \det \mathbf{J} = 0.000120311$$

$$\mathbf{B}^T = \begin{pmatrix} -10.2861 & 20.5723 & 12.7611 & -23.0472 & 21.5755 & -26.0243 & 48.736 & 17.4582 & 19.490 \\ -4.32827 & -58.0101 & 58.0101 & 4.32827 & 9.86593 & 48.3097 & -9.86593 & 3.6045 & 10.968 \end{pmatrix}$$

$$k_x = 45. \quad k_y = 45. \quad p = 0. \quad q = 5. \times 10^6$$

$$k_k = \begin{pmatrix} 0.152955 & 0.0484816 & -0.469587 & 0.268151 & -0.325014 & 0.0719617 & -0.563244 & - \\ 0.0484816 & 4.65281 & -3.8106 & -0.890693 & -0.157779 & -4.09944 & 1.93429 & - \\ -0.469587 & -3.8106 & 4.33303 & -0.0528404 & 1.04106 & 3.03403 & 0.0609163 & - \\ 0.268151 & -0.890693 & -0.0528404 & 0.675383 & -0.558271 & 0.993453 & -1.43197 & - \\ -0.325014 & -0.157779 & 1.04106 & -0.558271 & 0.691267 & -0.104234 & 1.17189 & - \\ 0.0719617 & -4.09944 & 3.03403 & 0.993453 & -0.104234 & 3.69815 & -2.14309 & - \\ -0.563244 & 1.93429 & 0.0609163 & -1.43197 & 1.17189 & -2.14309 & 3.0367 & - \\ -0.239714 & 0.184298 & 0.530428 & -0.475012 & 0.506294 & -0.344143 & 1.00131 & - \\ -0.304537 & -0.288982 & 1.08692 & -0.493403 & 0.649382 & 0.0277964 & 1.03375 & - \\ 0.293712 & 4.31843 & -4.23808 & -0.374067 & -0.674002 & -3.61774 & 0.843498 & - \\ -0.510879 & 1.91981 & -0.0753096 & -1.33363 & 1.06098 & -2.09083 & 2.82971 & - \\ -0.0856559 & 0.537349 & -0.18276 & -0.268933 & 0.175344 & -0.542086 & 0.572607 & - \\ -0.191426 & -0.45246 & 0.897053 & -0.253167 & 0.411387 & 0.258198 & 0.526414 & - \\ 0.252017 & 6.81321 & -6.0904 & -0.974829 & -0.615019 & -5.86673 & 2.13968 & - \\ -0.288743 & 1.4128 & -0.30135 & -0.822705 & 0.595786 & -1.47305 & 1.74864 & - \\ 0.0583057 & 0.429345 & -0.503425 & 0.0157747 & -0.128745 & -0.337788 & -0.0275158 & - \\ 0.507621 & -0.342516 & -1.16095 & 0.995842 & -1.0727 & 0.686311 & -2.09863 & - \end{pmatrix}$$

$$k_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$r_q^T = (3.12682 \quad 41.9076 \quad 85.0814 \quad 6.34812 \quad -7.12733 \quad -68.776 \quad -14.47 \quad -5.13154 \quad -7.92361 \quad -30.$$

Gauss point = {s → 0.861136, t → 0.861136}

Weight = 0.121003

$$\mathbf{N}^T = \{0.00482078, 0.0646111, 0.865957, 0.0646111, \\ -0.0109886, -0.147276, -0.147276, -0.0109886, -0.0122162, -0.16373, \\ -0.16373, -0.0122162, -0.0113627, -0.15229, -0.15229, -0.0113627, 0.0250475\}$$

$$\partial \mathbf{N}^T / \partial s = \begin{pmatrix} -0.0347159 & 0.0347159 & 0.465284 & -0.465284 & 0.0732278 & -0.0791321 & 0.981444 & 0.0791321 \end{pmatrix}$$

$$\partial \mathbf{N}^T / \partial t = \begin{pmatrix} -0.0347159 & -0.465284 & 0.465284 & 0.0347159 & 0.0791321 & 0.981444 & -0.0791321 & 0.0732278 \end{pmatrix}$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 66.6667 & -4.32827 \\ 0. & 124.677 \end{pmatrix} \quad \det \mathbf{J} = 0.000120311$$

$$\mathbf{B}^T = \begin{pmatrix} -2.16413 & 4.32827 & 29.0051 & -31.1692 & 4.53935 & -9.52343 & 65.7721 & 4.95852 & 4.1007 \\ -4.32827 & -58.0101 & 58.0101 & 4.32827 & 9.86593 & 122.363 & -9.86593 & 9.12981 & 10.9681 \end{pmatrix}$$

$$k_x = 45.$$

$$k_y = 45.$$

$$p = 0.$$

$$q = 5. \times 10^6$$

$$\mathbf{k}_k = \begin{pmatrix} 0.015341 & 0.158351 & -0.205609 & 0.0319172 & -0.0344104 & -0.333459 & -0.0652734 & -0.0329174 \\ 0.158351 & 2.21683 & -2.12232 & -0.252867 & -0.362064 & -4.67718 & 0.561432 & -0.0329174 \\ -0.205609 & -2.12232 & 2.7557 & -0.427774 & 0.46119 & 4.46922 & 0.874835 & -0.0329174 \\ 0.0319172 & -0.252867 & -0.427774 & 0.648725 & -0.0647154 & 0.541422 & -1.37099 & -0.0329174 \\ -0.0344104 & -0.362064 & 0.46119 & -0.0647154 & 0.0772652 & 0.762547 & 0.131825 & -0.0329174 \\ -0.333459 & -4.67718 & 4.46922 & 0.541422 & 0.762547 & 9.86824 & -1.20121 & -0.0329174 \\ -0.0652734 & 0.561432 & 0.874835 & -1.37099 & 0.131825 & -1.20121 & 2.89776 & -0.0329174 \\ -0.0329174 & -0.332901 & 0.44118 & -0.0753618 & 0.073754 & 0.700923 & 0.154644 & -0.0329174 \\ -0.036914 & -0.405196 & 0.494744 & -0.0526341 & 0.083085 & 0.853641 & 0.105803 & -0.0329174 \\ -0.304665 & -4.29653 & 4.0833 & 0.517891 & 0.696976 & 9.06538 & -1.14674 & -0.0329174 \\ -0.0545953 & 0.588215 & 0.73172 & -1.26534 & 0.108859 & -1.25633 & 2.67534 & -0.0329174 \\ -0.031667 & -0.302703 & 0.424421 & -0.0900503 & 0.070745 & 0.637068 & 0.185999 & -0.0329174 \\ -0.0321667 & -0.381223 & 0.431117 & -0.0177274 & 0.0727321 & 0.803542 & 0.0325118 & -0.0329174 \\ -0.176569 & -2.53575 & 2.36648 & 0.345837 & 0.404472 & 5.35076 & -0.761517 & -0.0329174 \\ -0.0217199 & 0.488996 & 0.291104 & -0.75838 & 0.040297 & -1.04067 & 1.6052 & -0.0329174 \\ -0.0214852 & -0.172576 & 0.287958 & -0.0938964 & 0.0476112 & 0.36266 & 0.195768 & -0.0329174 \\ 0.0737606 & 0.761363 & -0.988584 & 0.153461 & -0.165448 & -1.60329 & -0.31384 & -0.0329174 \end{pmatrix}$$

$$\mathbf{r}_q^T = (0.350905 \quad 4.70304 \quad 63.033 \quad 4.70304 \quad -0.799858 \quad -10.7202 \quad -10.7202 \quad -0.799858 \quad -0.88922)$$

Adding contributions from all Gauss points

$$k_k = \begin{pmatrix} 22.5818 & -0.163551 & -11.0864 & -11.3318 & -9.5862 \\ -0.163551 & 45.3271 & -22.8271 & -22.3364 & -17.5699 \\ -11.0864 & -22.8271 & 34.0771 & -0.163551 & 8.38435 \\ -11.3318 & -22.3364 & -0.163551 & 33.8318 & 18.7718 \\ -9.5862 & -17.5699 & 8.38435 & 18.7718 & 35.7126 \\ 1.04447 & -2.08893 & -7.09665 & 8.14112 & 6.13318 \\ 9.5862 & 17.5699 & -17.5699 & -9.5862 & -1.96262 \\ -7.41142 & 14.8228 & 3.54833 & -10.9597 & -8.69159 \\ 2.40126 & -4.80252 & 4.80252 & -2.40126 & -3.04952 \\ -0.26968 & 0.53936 & -0.53936 & 0.26968 & -1.58358 \\ -2.40126 & 4.80252 & -4.80252 & 2.40126 & 0.144784 \\ 1.91362 & -3.82724 & 3.82724 & -1.91362 & 2.24416 \\ 0.284121 & -0.568242 & 0.568242 & -0.284121 & -1.3919 \\ 4.44089 \times 10^{-16} & 0. & -3.33067 \times 10^{-16} & 8.88178 \times 10^{-16} & -2.22045 \times 10^{-16} \\ -0.284121 & 0.568242 & -0.568242 & 0.284121 & 1.3919 \\ -8.88178 \times 10^{-16} & 1.33227 \times 10^{-15} & -6.66134 \times 10^{-16} & 0. & 0. \\ 2.55841 & -5.11682 & 5.11682 & -2.55841 & -12.5336 \end{pmatrix}$$

$$k_p = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$r_q^T = (937.5 \quad 750. \quad 750. \quad 937.5 \quad -688.919 \quad -612.372 \quad -688.919 \quad -765.466 \quad 59.2927 \quad 3.55271 \times 10^{-1}$$

Natural boundary conditions

Specified NBC values for side 2: $\alpha = -55$ $\beta = 1100$

Interpolation functions for mapping: $\left\{0, \frac{1-a}{2}, \frac{a+1}{2}, 0\right\}$

Interpolation functions for solution:

$$\left\{0, \frac{1-a}{2}, \frac{a+1}{2}, 0, 0, \frac{\frac{3a^2}{2} - \frac{3}{2}}{\sqrt{6}}, 0, 0, 0, \frac{\frac{5a^3}{2} - \frac{5a}{2}}{\sqrt{10}}, 0, 0, 0, \frac{\frac{35a^4}{8} - \frac{21a^2}{4} + \frac{7}{8}}{\sqrt{14}}, 0, 0, 0\right\}$$

$$x(a) = 0.03 \quad y(a) = 0.0075a + 0.0225$$

$$J_c = 0.0075$$

Value in mapped coordinate: $\alpha(a) = -55$ $\beta(a) = 1100$

Gauss point = -0.861136 Weight = 0.347855

$$\mathbf{N}_c^T = \{0., 0.930568, 0.0694318, 0., 0., -0.158264, 0., 0., 0., 0.175946, 0., 0., 0., -0.163653, 0., 0., 0.\}$$

$$J_c = 0.0075 \quad \alpha = -55. \quad \beta = 1100.$$

$$\mathbf{k}_\alpha = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & -0.124256 & -0.00927105 & 0. & 0. & 0.0211326 & 0. & 0. & 0. & -0.0234936 & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & -0.00927105 & -0.000691734 & 0. & 0. & 0.00157675 & 0. & 0. & 0. & -0.00175291 & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0.0211326 & 0.00157675 & 0. & 0. & -0.00359407 & 0. & 0. & 0. & 0.00399561 & 0. & 0. & 0. & 0. & 0. & 0. & -0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & -0.0234936 & -0.00175291 & 0. & 0. & 0.00399561 & 0. & 0. & 0. & -0.00444201 & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0.0218522 & 0.00163044 & 0. & 0. & -0.00371645 & 0. & 0. & 0. & 0.00413166 & 0. & 0. & 0. & 0. & 0. & 0. & -0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

Gauss point = -0.339981 Weight = 0.652145

$$\mathbf{N}_c^T = \{0., 0.669991, 0.330009, 0., 0., -0.54159, 0., 0., 0., 0.237711, 0., 0., 0., 0.0872927, 0., 0., 0.\}$$

$$J_c = 0.0075 \quad \alpha = -55. \quad \beta = 1100.$$

Gauss point = 0.339981 Weight = 0.652145

$$\mathbf{N}_c^T = \{0., 0.330009, 0.669991, 0., 0., -0.54159, 0., 0., 0., -0.237711, 0., 0., 0., 0.0872927, 0., 0., 0.\}$$

$\mathbf{J}_c = 0.0075$ $\alpha = -55.$ $\beta = 1100.$

[illegible]

Gauss point = 0.861136

Weight = 0.347855

$$\mathbf{N}_c^T = \{0., 0.0694318, 0.930568, 0., 0., -0.158264, 0., 0., 0., -0.175946, 0., 0., 0., -0.163653, 0., 0., 0.\}$$

$$J_c = 0.0075$$

$$\alpha = -55.$$

$$\beta = 1100.$$

$$\mathbf{k}_\alpha = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & -0.000691734 & -0.00927105 & 0. & 0. & 0.00157675 & 0. & 0. & 0. & 0.00175291 & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & -0.00927105 & -0.124256 & 0. & 0. & 0.0211326 & 0. & 0. & 0. & 0.0234936 & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0.00157675 & 0.0211326 & 0. & 0. & -0.00359407 & 0. & 0. & 0. & -0.00399561 & 0. & 0. & 0. & 0. & 0. & 0. & -0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0.00175291 & 0.0234936 & 0. & 0. & -0.00399561 & 0. & 0. & 0. & -0.00444201 & 0. & 0. & 0. & 0. & 0. & 0. & -0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0.00163044 & 0.0218522 & 0. & 0. & -0.00371645 & 0. & 0. & 0. & -0.00413166 & 0. & 0. & 0. & 0. & 0. & 0. & -0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

Adding contributions from all Gauss points

$$k_\alpha = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & -0.275 & -0.1375 & 0. & 0. & 0.168402 & 0. & 0. & 0. & -0.0434813 \\ 0. & -0.1375 & -0.275 & 0. & 0. & 0.168402 & 0. & 0. & 0. & 0.0434813 \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0.168402 & 0.168402 & 0. & 0. & -0.165 & 0. & 0. & 0. & -1.73472 \times 10^{-18} \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & -0.0434813 & 0.0434813 & 0. & 0. & -1.73472 \times 10^{-18} & 0. & 0. & 0. & -0.0392857 \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 2.38524 \times 10^{-18} & 3.46945 \times 10^{-18} & 0. & 0. & 0.018003 & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

Specified NBC values for side 3: $\alpha = -55$ $\beta = 1100$

Interpolation functions for mapping: $\left\{0, 0, \frac{1-a}{2}, \frac{a+1}{2}\right\}$

Interpolation functions for solution:

$$\left\{0, 0, \frac{1-a}{2}, \frac{a+1}{2}, 0, 0, \frac{\frac{3a^2}{2} - \frac{3}{2}}{\sqrt{6}}, 0, 0, 0, \frac{\frac{5a}{2} - \frac{5a^3}{2}}{\sqrt{10}}, 0, 0, 0, \frac{\frac{35a^4}{8} - \frac{21a^2}{4} + \frac{7}{8}}{\sqrt{14}}, 0, 0\right\}$$

$$x(a) = 0.015 - 0.015 a \quad y(a) = 0.03$$

$$J_c = 0.015$$

Value in mapped coordinate: $\alpha(a) = -55$ $\beta(a) = 1100$

Gauss point = -0.861136 Weight = 0.347855

$$\mathbf{N}_c^T = \{0., 0., 0.930568, 0.0694318, 0., 0., -0.158264, 0., 0., 0., -0.175946, 0., 0., 0., -0.163653, 0., 0.\}$$

$$J_c = 0.015 \quad \alpha = -55. \quad \beta = 1100.$$

Gauss point = -0.339981 Weight = 0.652145

$$\mathbf{N}_c^T = \{0., 0., 0.669991, 0.330009, 0., 0., -0.54159, 0., 0., 0., -0.237711, 0., 0., 0., 0.0872927, 0., 0.\}$$

$\mathbf{J}_c = 0.015$ $\alpha = -55.$ $\beta = 1100.$

[illegible]

Gauss point = 0.339981

Weight = 0.652145

$$\mathbf{N}_c^T = \{0., 0., 0.330009, 0.669991, 0., 0., -0.54159, 0., 0., 0., 0.237711, 0., 0., 0., 0.0872927, 0., 0.\}$$

$$J_c = 0.015$$

$$\alpha = -55.$$

$$\beta = 1100.$$

$$\mathbf{k}_\alpha = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & -0.0585937 & -0.118958 & 0. & 0. & 0.0961602 & 0. & 0. & -0.042206 & 0. & 0. & 0. & -0.015499 & 0. & 0. & 0. \\ 0. & 0. & -0.118958 & -0.24151 & 0. & 0. & 0.195226 & 0. & 0. & -0.0856873 & 0. & 0. & 0. & -0.0314662 & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0.0961602 & 0.195226 & 0. & 0. & -0.157812 & 0. & 0. & 0.0692658 & 0. & 0. & 0. & -0.0111642 & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & -0.042206 & -0.0856873 & 0. & 0. & 0.0692658 & 0. & 0. & -0.0304017 & 0. & 0. & 0. & -0.015499 & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & -0.015499 & -0.0314662 & 0. & 0. & 0.0254359 & 0. & 0. & -0.0111642 & 0. & 0. & 0. & -0.015499 & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

Gauss point = 0.861136

Weight = 0.347855

$$\mathbf{N}_c^T = \{0., 0., 0.0694318, 0.930568, 0., 0., -0.158264, 0., 0., 0., 0.175946, 0., 0., 0., -0.163653, 0., 0.\}$$

$$J_c = 0.015$$

$$\alpha = -55.$$

$$\beta = 1100.$$

$$k_\alpha = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & -0.00138347 & -0.0185421 & 0. & 0. & 0.0031535 & 0. & 0. & 0. & -0.00350582 & 0. & 0. \\ 0. & 0. & -0.0185421 & -0.248513 & 0. & 0. & 0.0422652 & 0. & 0. & 0. & -0.0469871 & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0.0031535 & 0.0422652 & 0. & 0. & -0.00718815 & 0. & 0. & 0. & 0.00799122 & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & -0.00350582 & -0.0469871 & 0. & 0. & 0.00799122 & 0. & 0. & 0. & -0.00888402 & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0.00326088 & 0.0437043 & 0. & 0. & -0.00743291 & 0. & 0. & 0. & 0.00826333 & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix} -$$

Adding contributions from all Gauss points

$$k_\alpha = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & -0.55 & -0.275 & 0. & 0. & 0.336805 & 0. & 0. & 0. & 0.0869626 & 0. & 0. \\ 0. & 0. & -0.275 & -0.55 & 0. & 0. & 0.336805 & 0. & 0. & 0. & -0.0869626 & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0.336805 & 0.336805 & 0. & 0. & -0.33 & 0. & 0. & 0. & 3.46945 \times 10^{-18} & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0.0869626 & -0.0869626 & 0. & 0. & 3.46945 \times 10^{-18} & 0. & 0. & 0. & -0.0785714 & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 4.77049 \times 10^{-18} & 6.93889 \times 10^{-18} & 0. & 0. & 0.036006 & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

Specified NBC values for side 4: $\alpha = 0$

$\beta = 8000$

Interpolation functions for mapping: $\left\{ \frac{a+1}{2}, 0, 0, \frac{1-a}{2} \right\}$

Interpolation functions for solution:

$$\left\{ \frac{a+1}{2}, 0, 0, \frac{1-a}{2}, 0, 0, 0, \frac{\frac{3a^2}{2} - \frac{3}{2}}{\sqrt{6}}, 0, 0, 0, \frac{\frac{5a}{2} - \frac{5a^3}{2}}{\sqrt{10}}, 0, 0, 0, \frac{\frac{35a^4}{8} - \frac{21a^2}{4} + \frac{7}{8}}{\sqrt{14}}, 0 \right\}$$

$$x(a) = 0 \quad y(a) = 0.015 - 0.015 a$$

$$J_c = 0.015$$

$$\text{Value in mapped coordinate: } \alpha(a) = 0 \quad \beta(a) = 8000$$

$$\text{Gauss point} = -0.861136 \quad \text{Weight} = 0.347855$$

$$\mathbf{N}_c^T = \{0.0694318, 0., 0., 0.930568, 0., 0., 0., -0.158264, 0., 0., 0., -0.175946, 0., 0., 0., -0.163653, 0.\}$$

$$J_c = 0.015 \quad \alpha = 0. \quad \beta = 8000.$$

$$\mathbf{k}_\alpha = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix} \quad \mathbf{r}_\beta = \begin{pmatrix} -2.89826 \\ 0. \\ 0. \\ -38.8443 \\ 0. \\ 0. \\ 0. \\ 6.60635 \\ 0. \\ 0. \\ 0. \\ 7.34443 \\ 0. \\ 0. \\ 0. \\ 6.8313 \\ 0. \end{pmatrix}$$

$$\text{Gauss point} = -0.339981 \quad \text{Weight} = 0.652145$$

$$\mathbf{N}_c^T = \{0.330009, 0., 0., 0.669991, 0., 0., 0., -0.54159, 0., 0., 0., -0.237711, 0., 0., 0., 0.0872927, 0.\}$$

$$J_c = 0.015 \quad \alpha = 0. \quad \beta = 8000.$$

Gauss point = 0.339981 Weight = 0.652145

$$\mathbf{N}_c^T = \{0.669991, 0., 0., 0.330009, 0., 0., 0., -0.54159, 0., 0., 0., 0.237711, 0., 0., 0., 0.0872927, 0.\}$$

$\mathbf{J}_c = 0.015$ $\alpha = 0.$ $\beta = 8000.$

[illegible]

Gauss point = 0.861136

Weight = 0.347855

$$\mathbf{N}_c^T = \{0.930568, 0., 0., 0.0694318, 0., 0., 0., -0.158264, 0., 0., 0., 0.175946, 0., 0., 0., -0.163653, 0.\}$$

$$J_c = 0.015$$

$$\alpha = 0.$$

$$\beta = 8000.$$

$$\mathbf{k}_\alpha = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_\beta = \begin{pmatrix} -38.8443 \\ 0. \\ 0. \\ -2.89826 \\ 0. \\ 0. \\ 0. \\ 6.60635 \\ 0. \\ 0. \\ 0. \\ -7.34443 \\ 0. \\ 0. \\ 0. \\ 6.8313 \\ 0. \end{pmatrix}$$

Adding contributions from all Gauss points

$$\mathbf{k}_\alpha = \begin{pmatrix} 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. & 0. \end{pmatrix}$$

$$\mathbf{r}_\beta = \begin{pmatrix} -120. \\ 0. \\ 0. \\ -120. \\ 0. \\ 0. \\ 0. \\ 97.9796 \\ 0. \\ 0. \\ 0. \\ 0. \\ 0. \\ 0. \\ 0. \\ 0. \\ 0. \\ 7.10543 \times 10^{-15} \\ 0. \end{pmatrix}$$

$$\begin{pmatrix} 22.5818 & -0.163551 & -11.0864 & -11.3318 & -9.5862 & 1.04447 & 9.5862 & -7.41142 \\ -0.163551 & 45.0521 & -22.9646 & -22.3364 & -17.5699 & -1.92053 & 17.5699 & 14.8228 \\ -11.0864 & -22.9646 & 33.2521 & -0.438551 & 8.38435 & -6.92825 & -17.2331 & 3.54833 \\ -11.3318 & -22.3364 & -0.438551 & 33.2818 & 18.7718 & 8.14112 & -9.2494 & -10.9597 \\ -9.5862 & -17.5699 & 8.38435 & 18.7718 & 35.7126 & 6.13318 & -1.96262 & -8.69159 \\ 1.04447 & -1.92053 & -6.92825 & 8.14112 & 6.13318 & 58.307 & 1.36682 & 15.764 \\ 9.5862 & 17.5699 & -17.2331 & -9.2494 & -1.96262 & 1.36682 & 35.3826 & 1.19159 \\ -7.41142 & 14.8228 & 3.54833 & -10.9597 & -8.69159 & 15.764 & 1.19159 & 47.243 \\ 2.40126 & -4.80252 & 4.80252 & -2.40126 & -3.04952 & -0.452451 & -5.66469 & 0.226226 \\ -0.26968 & 0.495879 & -0.495879 & 0.26968 & -1.58358 & -3.16716 & 1.58358 & 1.58358 \\ -2.40126 & 4.80252 & -4.71556 & 2.3143 & 0.144784 & 0.452451 & -3.04952 & -0.226226 \\ 1.91362 & -3.82724 & 3.82724 & -1.91362 & 2.24416 & -4.2259 & -2.24416 & -2.24416 \\ 0.284121 & -0.568242 & 0.568242 & -0.284121 & -1.3919 & -0.0535348 & 1.3919 & 0.0267674 \\ 0 & 0 & 0 & 0 & 0 & 0.330034 & 0 & -0.156016 \\ -0.284121 & 0.568242 & -0.568242 & 0.284121 & 1.3919 & 0.0535348 & -1.3559 & -0.0267674 \\ 0 & 0 & 0 & 0 & 0 & 2.29894 & 0 & -0.412982 \\ 2.55841 & -5.11682 & 5.11682 & -2.55841 & -12.5336 & -31.2997 & -15.0232 & -23.8482 \end{pmatrix}$$

Global equations after assembling all elements

47.722	19.8598	-5.96963	-39.1939	-11.0864	-11.3318	-29.6457	-4.14925
19.8598	70.1402	-39.0304	-50.9696	0	0	-43.839	31.3054
-5.96963	-39.0304	43.7607	0.414252	0	0	14.1933	-16.6829
-39.1939	-50.9696	0.414252	133.813	-22.9646	-22.3364	59.2914	-37.6294
-11.0864	0	0	-22.9646	33.2521	-0.438551	0	8.38435
-11.3318	0	0	-22.3364	-0.438551	33.2818	0	18.7718
-29.6457	-43.839	14.1933	59.2914	0	0	58.5981	-34.7664
-4.14925	31.3054	-16.6829	-37.6294	8.38435	18.7718	-34.7664	132.827
-7.41142	0	0	14.8228	3.54833	-10.9597	0	-8.69159
-5.43695	5.43695	-20.0595	20.0595	0	0	4.76636	37.8855
4.17787	32.5645	-28.0498	-8.01893	0	0	-13.6963	24.5327
1.04447	0	0	-1.92053	-6.92825	8.14112	0	6.13318
9.5862	0	0	17.5699	-17.2331	-9.2494	0	-1.96262
7.65449	-7.65449	15.309	-15.309	0	0	-8.97663	8.97663
3.69425	-1.29299	2.58597	-7.3885	4.80252	-2.40126	0.904903	-18.0981
1.91362	0	0	-3.82724	3.82724	-1.91362	0	2.24416
-1.29299	1.29299	-2.58597	2.58597	0	0	-0.904903	3.42958
-1.07872	1.07872	-2.07048	2.07048	0	0	6.33432	-6.33432
-0.26968	0	0	0.495879	-0.495879	0.26968	0	-1.58358
-2.40126	0	0	4.80252	-4.71556	2.3143	0	0.144784
0	0	0	0	0	0	-1.65193	0
0.43711	-0.152988	0.305977	-0.874219	0.568242	-0.284121	0.10707	-2.14139
0	0	0	0	0	0	0	0
-0.152988	0.152988	-0.305977	0.305977	0	0	-0.10707	0.749487
0	0	0	0	0	0	-0.624062	0
0	0	0	0	0	0	0	0
-0.284121	0	0	0.568242	-0.568242	0.284121	0	1.3919
10.2336	-10.2336	20.4673	-20.4673	0	0	-7.82921	-50.1344
2.55841	0	0	-5.11682	5.11682	-2.55841	0	-12.5336

Essential boundary conditions

On element 1, side 1, specified value = 110

$$\{T_1, T_2, \delta_1^{(1,2)}, \delta_2^{(1,2)}, \delta_3^{(1,2)}\} = \{110, 110, 0, 0, 0\}$$

Known values from EBC

$$\{T_1 = 110, T_2 = 110, \delta_1^{(1,2)} = 0, \delta_2^{(1,2)} = 0, \delta_3^{(1,2)} = 0\}$$

Global equations after EBC

43.7607	0.414252	0	0	-16.6829	0	-20.0595	-28.0498
0.414252	133.813	-22.9646	-22.3364	-37.6294	14.8228	20.0595	-8.01893
0	-22.9646	33.2521	-0.438551	8.38435	3.54833	0	0
0	-22.3364	-0.438551	33.2818	18.7718	-10.9597	0	0
-16.6829	-37.6294	8.38435	18.7718	132.827	-8.69159	37.8855	24.5327
0	14.8228	3.54833	-10.9597	-8.69159	47.243	0	0
-20.0595	20.0595	0	0	37.8855	0	97.1145	5.46729
-28.0498	-8.01893	0	0	24.5327	0	5.46729	49.5625
0	-1.92053	-6.92825	8.14112	6.13318	15.764	0	0
0	17.5699	-17.2331	-9.2494	-1.96262	1.19159	0	0
2.58597	-7.3885	4.80252	-2.40126	-18.0981	0.226226	-19.8083	-1.80981
0	-3.82724	3.82724	-1.91362	2.24416	-2.24416	0	0
-2.58597	2.58597	0	0	3.42958	0	-15.0485	1.80981
-2.07048	2.07048	0	0	-6.33432	0	6.33432	-12.6686
0	0.495879	-0.495879	0.26968	-1.58358	1.58358	0	0
0	4.80252	-4.71556	2.3143	0.144784	-0.226226	0	0
0.305977	-0.874219	0.568242	-0.284121	-2.14139	0.0267674	0.749487	-0.214139
0	0	0	0	0	-0.412982	0	0
-0.305977	0.305977	0	0	0.749487	0	-0.749487	0.214139
0	0	0	0	0	0	0	1.28413
0	0	0	0	0	-0.156016	0	0
0	0.568242	-0.568242	0.284121	1.3919	-0.0267674	0	0
20.4673	-20.4673	0	0	-50.1344	0	-60.0926	-24.7582
0	-5.11682	5.11682	-2.55841	-12.5336	-23.8482	0	0

Solving the final system of global equations we get

$$\{T_3 = 126.672, T_4 = 139.179, T_5 = 161.022, T_6 = 157.838, \delta_1^{(1,4)} = -10.2723, \delta_1^{(1,6)} = -18.1555, \delta_1^{(2,3)} = -3.1219, \\ \delta_1^{(3,4)} = 9.11823, \delta_1^{(4,5)} = -7.80844, \delta_1^{(5,6)} = -0.417322, \delta_2^{(1,4)} = -1.97672, \delta_2^{(1,6)} = -0.489402, \delta_2^{(2,3)} = 0.628592, \\ \delta_2^{(3,4)} = 1.57953, \delta_2^{(4,5)} = -0.116878, \delta_2^{(5,6)} = 2.87472, \delta_3^{(1,4)} = -0.453533, \delta_3^{(1,6)} = -0.0551927, \\ \delta_3^{(2,3)} = 0.290689, \delta_3^{(3,4)} = -0.356589, \delta_3^{(4,5)} = 0.0993939, \delta_3^{(5,6)} = 1.207, \delta_1^1 = 5.59898, \delta_1^2 = -5.68136\}$$

Solution for element 1

DOF values for the element

$$\{T_1 = 110, T_2 = 110, T_3 = 126.672, T_4 = 139.179, \delta_1^{(1,2)} = 0, \delta_1^{(2,3)} = -3.1219, \\ \delta_1^{(3,4)} = 9.11823, \delta_1^{(1,4)} = -10.2723, \delta_2^{(1,2)} = 0, \delta_2^{(2,3)} = 0.628592, \delta_2^{(3,4)} = 1.57953, \delta_2^{(1,4)} = -1.97672, \\ \delta_3^{(1,2)} = 0, \delta_3^{(2,3)} = 0.290689, \delta_3^{(3,4)} = -0.356589, \delta_3^{(1,4)} = -0.453533, \delta_1^1 = 5.59898\}$$

$$\mathbf{d}^T = (110 \quad 110 \quad 126.672 \quad 139.179 \quad 0 \quad -3.1219 \quad 9.11823 \quad -10.2723 \quad 0 \quad 0.628592 \quad 1.57953 \quad -1.97672 \quad 0 \quad 0.$$

Mapping

$$x(s,t) = -0.0075ts + 0.0225s + 0.0075t + 0.0375$$

$$y(s,t) = 0.0075t + 0.0075$$

$$\mathbf{J} = \begin{pmatrix} 0.0225 - 0.0075t & 0.0075 - 0.0075s \\ 0 & 0.0075 \end{pmatrix}$$

Element solution at $\{s \rightarrow 0, t \rightarrow 0\}$

Location: $\{0.0375, 0.0075\}$

$$\mathbf{N}^T = (0.25 \quad 0.25 \quad 0.25 \quad 0.25 \quad -0.306186 \quad -0.306186 \quad -0.306186 \quad -0.306186 \quad 0. \quad 0. \quad 0. \quad 0. \quad 0.1169$$

$$\partial \mathbf{N}^T / \partial s = (-0.25 \quad 0.25 \quad 0.25 \quad -0.25 \quad 0. \quad -0.306186 \quad 0. \quad 0.306186 \quad -0.395285 \quad 0. \quad -0.395285 \quad 0. \quad 0.$$

$$\partial \mathbf{N}^T / \partial t = (-0.25 \quad -0.25 \quad 0.25 \quad 0.25 \quad 0.306186 \quad 0. \quad -0.306186 \quad 0. \quad 0. \quad -0.395285 \quad 0. \quad -0.395285 \quad -$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 44.4444 & 0. \\ -44.4444 & 133.333 \end{pmatrix}$$

$$\mathbf{B}_x^T = \partial \mathbf{N}^T / \partial x = (-11.1111 \quad 11.1111 \quad 11.1111 \quad -11.1111 \quad 0. \quad -13.6083 \quad 0. \quad 13.6083 \quad -17.5682 \quad 0.$$

$$\mathbf{B}_y^T = \partial \mathbf{N}^T / \partial y = (-22.2222 \quad -44.4444 \quad 22.2222 \quad 44.4444 \quad 40.8248 \quad 13.6083 \quad -40.8248 \quad -13.6083 \quad 1$$

$$T = \mathbf{N}^T \mathbf{d} = 124.811$$

$$\partial T / \partial x = \mathbf{B}_x^T \mathbf{d} = -260.161$$

$$\partial T / \partial y = \mathbf{B}_y^T \mathbf{d} = 1481.78$$

	x	y	T	$\partial T / \partial x$	$\partial T / \partial y$
1	0.0375	0.0075	124.811	-260.161	1481.78

Solution for element 2

DOF values for the element

$$\{T_1 = 110, T_4 = 139.179, T_5 = 161.022, T_6 = 157.838, \delta_1^{[1,4]} = -10.2723, \delta_1^{[4,5]} = -7.80844, \delta_1^{[5,6]} = -0.417322, \\ \delta_1^{[1,6]} = -18.1555, \delta_2^{[1,4]} = -1.97672, \delta_2^{[4,5]} = -0.116878, \delta_2^{[5,6]} = 2.87472, \delta_2^{[1,6]} = -0.489402, \\ \delta_3^{[1,4]} = -0.453533, \delta_3^{[4,5]} = 0.0993939, \delta_3^{[5,6]} = 1.207, \delta_3^{[1,6]} = -0.0551927, \delta_1^2 = -5.68136\}$$

$$\mathbf{d}^T = (110 \quad 139.179 \quad 161.022 \quad 157.838 \quad -10.2723 \quad -7.80844 \quad -0.417322 \quad -18.1555 \quad -1.97672 \quad -0.116878)$$

Mapping

$$\mathbf{x}(s, t) = 0.015s + 0.015$$

$$\mathbf{y}(s, t) = -0.00375ts + 0.00375s + 0.01125t + 0.01875$$

$$\mathbf{J} = \begin{pmatrix} 0.015 & 0 \\ 0.00375 - 0.00375t & 0.01125 - 0.00375s \end{pmatrix}$$

Element solution at $\{s \rightarrow 0, t \rightarrow 0\}$

Location: $\{0.015, 0.01875\}$

$$\mathbf{N}^T = (0.25 \quad 0.25 \quad 0.25 \quad 0.25 \quad -0.306186 \quad -0.306186 \quad -0.306186 \quad -0.306186 \quad 0. \quad 0. \quad 0. \quad 0. \quad 0.1169)$$

$$\partial \mathbf{N}^T / \partial s = (-0.25 \quad 0.25 \quad 0.25 \quad -0.25 \quad 0. \quad -0.306186 \quad 0. \quad 0.306186 \quad -0.395285 \quad 0. \quad -0.395285 \quad 0. \quad 0.)$$

$$\partial \mathbf{N}^T / \partial t = (-0.25 \quad -0.25 \quad 0.25 \quad 0.25 \quad 0.306186 \quad 0. \quad -0.306186 \quad 0. \quad 0. \quad -0.395285 \quad 0. \quad -0.395285 \quad -0.)$$

$$\mathbf{J}^{-T} = \begin{pmatrix} 66.6667 & -22.2222 \\ 0. & 88.8889 \end{pmatrix}$$

$$\mathbf{B}_x^T = \partial \mathbf{N}^T / \partial x = (-11.1111 \quad 22.2222 \quad 11.1111 \quad -22.2222 \quad -6.80414 \quad -20.4124 \quad 6.80414 \quad 20.4124 \quad -0.395285 \quad 0.395285 \quad -0.395285 \quad 0.395285 \quad 0.)$$

$$\mathbf{B}_y^T = \partial \mathbf{N}^T / \partial y = (-22.2222 \quad -22.2222 \quad 22.2222 \quad 22.2222 \quad 27.2166 \quad 0. \quad -27.2166 \quad 0. \quad 0. \quad -35.1364 \quad 35.1364 \quad 0. \quad 0.)$$

$$T = \mathbf{N}^T \mathbf{d} = 151.195$$

$$\partial T / \partial x = \mathbf{B}_x^T \mathbf{d} = -23.981$$

$$\partial T / \partial y = \mathbf{B}_y^T \mathbf{d} = 1318.8$$

	x	y	T	$\partial T / \partial x$	$\partial T / \partial y$
1	0.015	0.01875	151.195	-23.981	1318.8

Nodal solution summary

dof	x	y	Value
T_1	0	0	110
T_2	0.06	0	110
T_3	0.06	0.015	126.672
T_4	0.03	0.015	139.179
T_5	0.03	0.03	161.022
T_6	0	0.03	157.838

Element solution summary

	x	y	T	$\partial T / \partial x$	$\partial T / \partial y$
1	0.0375	0.0075	124.811	-260.161	1481.78
2	0.015	0.01875	151.195	-23.981	1318.8