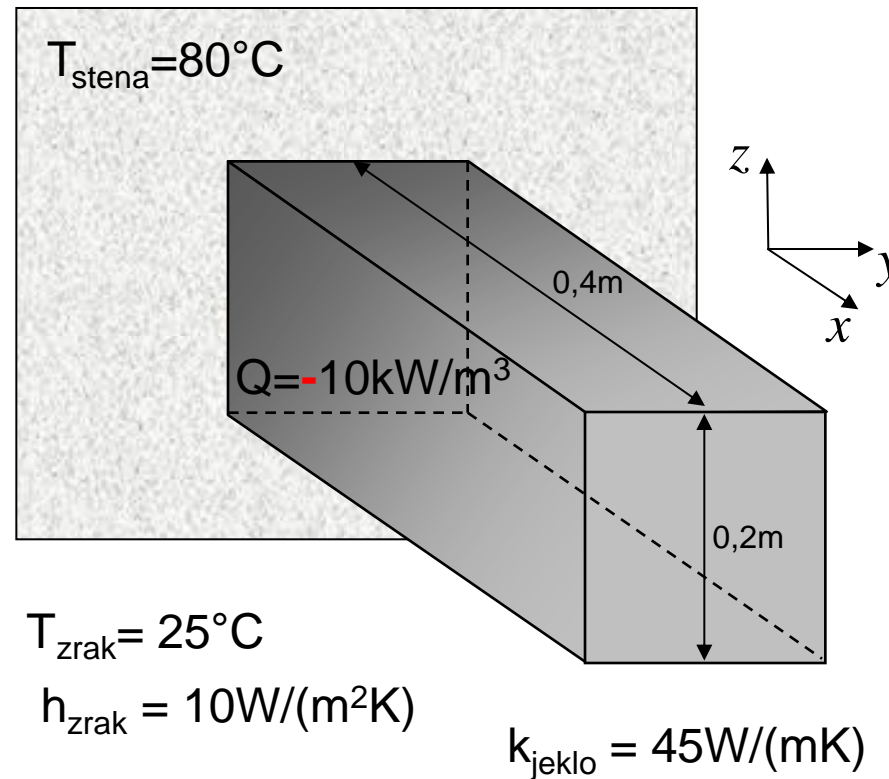
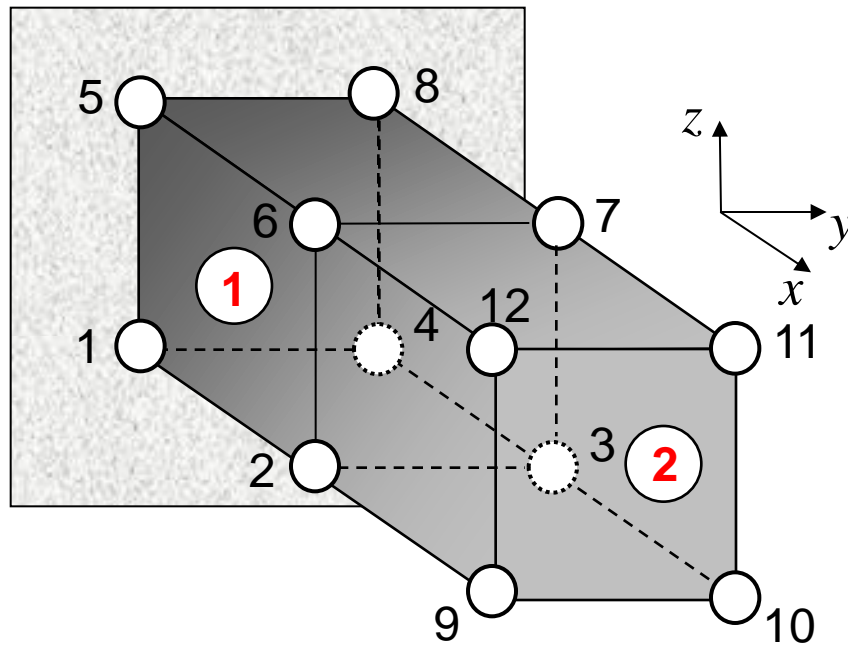


- primer reševanja volumskega problema ustaljenega prevoda toplote po MKE

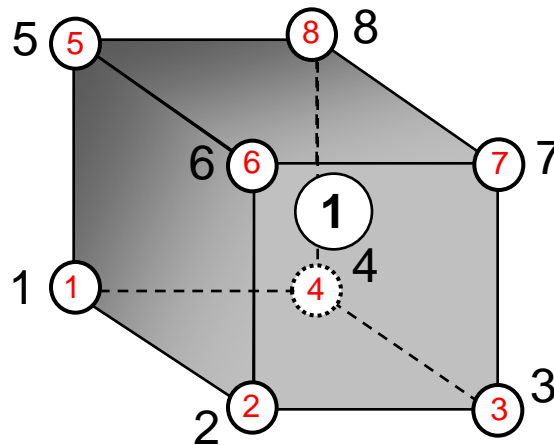


- mreža KE



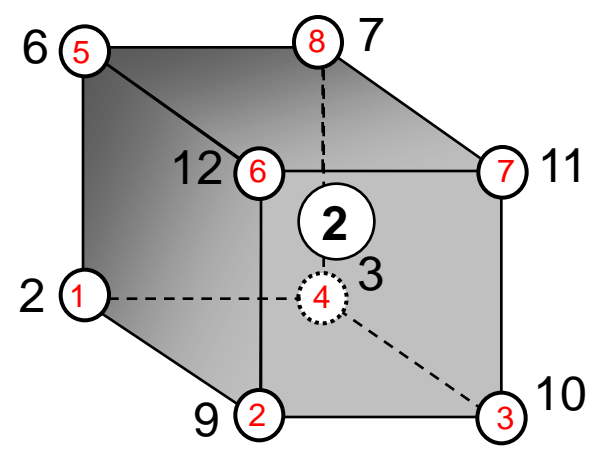
- sistem enačb za posamezni KE

$$k \begin{bmatrix} M_{1|1}^{(1)} & M_{1|2}^{(1)} & M_{1|3}^{(1)} & M_{1|4}^{(1)} & M_{1|5}^{(1)} & M_{1|6}^{(1)} & M_{1|7}^{(1)} & M_{1|8}^{(1)} \\ M_{2|1}^{(1)} & M_{2|2}^{(1)} & M_{2|3}^{(1)} & M_{2|4}^{(1)} & M_{2|5}^{(1)} & M_{2|6}^{(1)} & M_{2|7}^{(1)} & M_{2|8}^{(1)} \\ M_{3|1}^{(1)} & M_{3|2}^{(1)} & M_{3|3}^{(1)} & M_{3|4}^{(1)} & M_{3|5}^{(1)} & M_{3|6}^{(1)} & M_{3|7}^{(1)} & M_{3|8}^{(1)} \\ M_{4|1}^{(1)} & M_{4|2}^{(1)} & M_{4|3}^{(1)} & M_{4|4}^{(1)} & M_{4|5}^{(1)} & M_{4|6}^{(1)} & M_{4|7}^{(1)} & M_{4|8}^{(1)} \\ M_{5|1}^{(1)} & M_{5|2}^{(1)} & M_{5|3}^{(1)} & M_{5|4}^{(1)} & M_{5|5}^{(1)} & M_{5|6}^{(1)} & M_{5|7}^{(1)} & M_{5|8}^{(1)} \\ M_{6|1}^{(1)} & M_{6|2}^{(1)} & M_{6|3}^{(1)} & M_{6|4}^{(1)} & M_{6|5}^{(1)} & M_{6|6}^{(1)} & M_{6|7}^{(1)} & M_{6|8}^{(1)} \\ M_{7|1}^{(1)} & M_{7|2}^{(1)} & M_{7|3}^{(1)} & M_{7|4}^{(1)} & M_{7|5}^{(1)} & M_{7|6}^{(1)} & M_{7|7}^{(1)} & M_{7|8}^{(1)} \\ M_{8|1}^{(1)} & M_{8|2}^{(1)} & M_{8|3}^{(1)} & M_{8|4}^{(1)} & M_{8|5}^{(1)} & M_{8|6}^{(1)} & M_{8|7}^{(1)} & M_{8|8}^{(1)} \end{bmatrix} \begin{Bmatrix} T_1 \\ T_2 \\ T_3 \\ T_4 \\ T_5 \\ T_6 \\ T_7 \\ T_8 \end{Bmatrix} = \begin{Bmatrix} q_1^{(1)} \\ q_2^{(1)} \\ q_3^{(1)} \\ q_4^{(1)} \\ q_5^{(1)} \\ q_6^{(1)} \\ q_7^{(1)} \\ q_8^{(1)} \end{Bmatrix} + \begin{Bmatrix} Q_1^{(1)} \\ Q_2^{(1)} \\ Q_3^{(1)} \\ Q_4^{(1)} \\ Q_5^{(1)} \\ Q_6^{(1)} \\ Q_7^{(1)} \\ Q_8^{(1)} \end{Bmatrix}$$



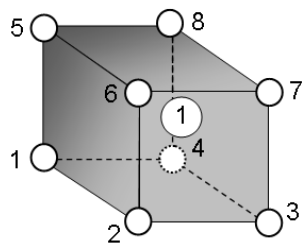
- sistem enačb za posamezni KE

$$\begin{matrix} k \\ \left[\begin{array}{cccccccc} M_{2|2}^{(2)} & M_{2|9}^{(2)} & M_{2|10}^{(2)} & M_{2|3}^{(2)} & M_{2|6}^{(2)} & M_{2|12}^{(2)} & M_{2|11}^{(2)} & M_{2|7}^{(2)} \\ M_{9|2}^{(2)} & M_{9|9}^{(2)} & M_{9|10}^{(2)} & M_{9|3}^{(2)} & M_{9|6}^{(2)} & M_{9|12}^{(2)} & M_{9|11}^{(2)} & M_{9|7}^{(2)} \\ M_{10|2}^{(2)} & M_{10|9}^{(2)} & M_{10|10}^{(2)} & M_{10|3}^{(2)} & M_{10|6}^{(2)} & M_{10|12}^{(2)} & M_{10|11}^{(2)} & M_{10|7}^{(2)} \\ M_{3|2}^{(2)} & M_{3|9}^{(2)} & M_{3|10}^{(2)} & M_{3|3}^{(2)} & M_{3|6}^{(2)} & M_{3|12}^{(2)} & M_{3|11}^{(2)} & M_{3|7}^{(2)} \\ M_{6|2}^{(2)} & M_{6|9}^{(2)} & M_{6|10}^{(2)} & M_{6|3}^{(2)} & M_{6|6}^{(2)} & M_{6|12}^{(2)} & M_{6|11}^{(2)} & M_{6|7}^{(2)} \\ M_{12|2}^{(2)} & M_{12|9}^{(2)} & M_{12|10}^{(2)} & M_{12|3}^{(2)} & M_{12|6}^{(2)} & M_{12|12}^{(2)} & M_{12|11}^{(2)} & M_{12|7}^{(2)} \\ M_{11|2}^{(2)} & M_{11|9}^{(2)} & M_{11|10}^{(2)} & M_{11|3}^{(2)} & M_{11|6}^{(2)} & M_{11|12}^{(2)} & M_{11|11}^{(2)} & M_{11|7}^{(2)} \\ M_{7|2}^{(2)} & M_{7|9}^{(2)} & M_{7|10}^{(2)} & M_{7|3}^{(2)} & M_{7|6}^{(2)} & M_{7|12}^{(2)} & M_{7|11}^{(2)} & M_{7|7}^{(2)} \end{array} \right] \begin{matrix} \left\{ \begin{array}{c} T_2 \\ T_9 \\ T_{10} \\ T_3 \\ T_6 \\ T_{12} \\ T_{11} \\ T_7 \end{array} \right\} = \left\{ \begin{array}{c} q_2^{(2)} \\ q_9^{(2)} \\ q_{10}^{(2)} \\ q_3^{(2)} \\ q_6^{(2)} \\ q_{12}^{(2)} \\ q_{11}^{(2)} \\ q_7^{(2)} \end{array} \right\} + \left\{ \begin{array}{c} Q_2^{(2)} \\ Q_9^{(2)} \\ Q_{10}^{(2)} \\ Q_3^{(2)} \\ Q_6^{(2)} \\ Q_{12}^{(2)} \\ Q_{11}^{(2)} \\ Q_7^{(2)} \end{array} \right\} \end{matrix}
 \end{matrix}$$



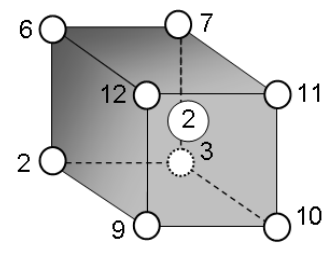
- razširitev sistem enačb za posamezni KE na vse prostostne stopnje problema

$$k \begin{bmatrix} M_{1|1}^{(1)} & M_{1|2}^{(1)} & M_{1|3}^{(1)} & M_{1|4}^{(1)} & M_{1|5}^{(1)} & M_{1|6}^{(1)} & M_{1|7}^{(1)} & M_{1|8}^{(1)} & 0 & 0 & 0 & 0 \\ M_{2|1}^{(1)} & M_{2|2}^{(1)} & M_{2|3}^{(1)} & M_{2|4}^{(1)} & M_{2|5}^{(1)} & M_{2|6}^{(1)} & M_{2|7}^{(1)} & M_{2|8}^{(1)} & 0 & 0 & 0 & 0 \\ M_{3|1}^{(1)} & M_{3|2}^{(1)} & M_{3|3}^{(1)} & M_{3|4}^{(1)} & M_{3|5}^{(1)} & M_{3|6}^{(1)} & M_{3|7}^{(1)} & M_{3|8}^{(1)} & 0 & 0 & 0 & 0 \\ M_{4|1}^{(1)} & M_{4|2}^{(1)} & M_{4|3}^{(1)} & M_{4|4}^{(1)} & M_{4|5}^{(1)} & M_{4|6}^{(1)} & M_{4|7}^{(1)} & M_{4|8}^{(1)} & 0 & 0 & 0 & 0 \\ M_{5|1}^{(1)} & M_{5|2}^{(1)} & M_{5|3}^{(1)} & M_{5|4}^{(1)} & M_{5|5}^{(1)} & M_{5|6}^{(1)} & M_{5|7}^{(1)} & M_{5|8}^{(1)} & 0 & 0 & 0 & 0 \\ M_{6|1}^{(1)} & M_{6|2}^{(1)} & M_{6|3}^{(1)} & M_{6|4}^{(1)} & M_{6|5}^{(1)} & M_{6|6}^{(1)} & M_{6|7}^{(1)} & M_{6|8}^{(1)} & 0 & 0 & 0 & 0 \\ M_{7|1}^{(1)} & M_{7|2}^{(1)} & M_{7|3}^{(1)} & M_{7|4}^{(1)} & M_{7|5}^{(1)} & M_{7|6}^{(1)} & M_{7|7}^{(1)} & M_{7|8}^{(1)} & 0 & 0 & 0 & 0 \\ M_{8|1}^{(1)} & M_{8|2}^{(1)} & M_{8|3}^{(1)} & M_{8|4}^{(1)} & M_{8|5}^{(1)} & M_{8|6}^{(1)} & M_{8|7}^{(1)} & M_{8|8}^{(1)} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \begin{Bmatrix} T_1 \\ T_2 \\ T_3 \\ T_4 \\ T_5 \\ T_6 \\ T_7 \\ T_8 \\ T_9 \\ T_{10} \\ T_{11} \\ T_{12} \end{Bmatrix} = \begin{Bmatrix} q_1^{(1)} \\ q_2^{(1)} \\ q_3^{(1)} \\ q_4^{(1)} \\ q_5^{(1)} \\ q_6^{(1)} \\ q_7^{(1)} \\ q_8^{(1)} \\ 0 \\ 0 \\ 0 \\ 0 \end{Bmatrix} + \begin{Bmatrix} Q_1^{(1)} \\ Q_2^{(1)} \\ Q_3^{(1)} \\ Q_4^{(1)} \\ Q_5^{(1)} \\ Q_6^{(1)} \\ Q_7^{(1)} \\ Q_8^{(1)} \\ 0 \\ 0 \\ 0 \\ 0 \end{Bmatrix}$$

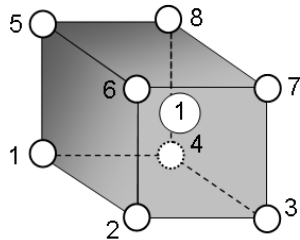


- razširitev sistem enačb za posamezni KE na vse prostostne stopnje problema

$$\begin{matrix}
 & \begin{matrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{matrix} \\
 \begin{matrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{matrix} & \begin{matrix} M_{2|2}^{(2)} & M_{2|3}^{(2)} & 0 & 0 & M_{2|6}^{(2)} & M_{2|7}^{(2)} & 0 & M_{2|9}^{(2)} & M_{2|10}^{(2)} & M_{2|11}^{(2)} & M_{2|12}^{(2)} \\ M_{3|2}^{(2)} & M_{3|3}^{(2)} & 0 & 0 & M_{3|6}^{(2)} & M_{3|7}^{(2)} & 0 & M_{3|9}^{(2)} & M_{3|10}^{(2)} & M_{3|11}^{(2)} & M_{3|12}^{(2)} \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ M_{6|2}^{(2)} & M_{6|3}^{(2)} & 0 & 0 & M_{6|6}^{(2)} & M_{6|7}^{(2)} & 0 & M_{6|9}^{(2)} & M_{6|10}^{(2)} & M_{6|11}^{(2)} & M_{6|12}^{(2)} \\ M_{7|2}^{(2)} & M_{7|3}^{(2)} & 0 & 0 & M_{7|6}^{(2)} & M_{7|7}^{(2)} & 0 & M_{7|9}^{(2)} & M_{7|10}^{(2)} & M_{7|11}^{(2)} & M_{7|12}^{(2)} \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ M_{9|2}^{(2)} & M_{9|3}^{(2)} & 0 & 0 & M_{9|6}^{(2)} & M_{9|7}^{(2)} & 0 & M_{9|9}^{(2)} & M_{9|10}^{(2)} & M_{9|11}^{(2)} & M_{9|12}^{(2)} \\ M_{10|2}^{(2)} & M_{10|3}^{(2)} & 0 & 0 & M_{10|6}^{(2)} & M_{10|7}^{(2)} & 0 & M_{10|9}^{(2)} & M_{10|10}^{(2)} & M_{10|11}^{(2)} & M_{10|12}^{(2)} \\ M_{11|2}^{(2)} & M_{11|3}^{(2)} & 0 & 0 & M_{11|6}^{(2)} & M_{11|7}^{(2)} & 0 & M_{11|9}^{(2)} & M_{11|10}^{(2)} & M_{11|11}^{(2)} & M_{11|12}^{(2)} \\ M_{12|2}^{(2)} & M_{12|3}^{(2)} & 0 & 0 & M_{12|6}^{(2)} & M_{12|7}^{(2)} & 0 & M_{12|9}^{(2)} & M_{12|10}^{(2)} & M_{12|11}^{(2)} & M_{12|12}^{(2)} \end{matrix} \\
 \end{matrix} \begin{matrix} T_1 \\ T_2 \\ T_3 \\ T_4 \\ T_5 \\ T_6 \\ T_7 \\ T_8 \\ T_9 \\ T_{10} \\ T_{11} \\ T_{12} \end{matrix} = \begin{matrix} 0 \\ q_2^{(2)} \\ q_3^{(2)} \\ 0 \\ 0 \\ q_6^{(2)} \\ q_7^{(2)} \\ 0 \\ q_9^{(2)} \\ q_{10}^{(2)} \\ q_{11}^{(2)} \\ q_{12}^{(2)} \end{matrix} + \begin{matrix} 0 \\ Q_2^{(2)} \\ Q_3^{(2)} \\ 0 \\ 0 \\ Q_6^{(2)} \\ Q_7^{(2)} \\ 0 \\ Q_9^{(2)} \\ Q_{10}^{(2)} \\ Q_{11}^{(2)} \\ Q_{12}^{(2)} \end{matrix}$$

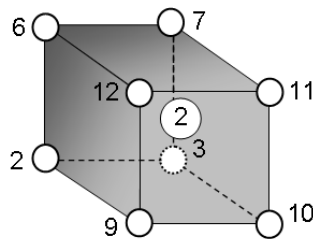


• sistem enačb za celotni problem



$$\begin{matrix} k \\ \left[\begin{array}{cccccccccccc} M_{11}^{(1)} & M_{12}^{(1)} & M_{13}^{(1)} & M_{14}^{(1)} & M_{15}^{(1)} & M_{16}^{(1)} & M_{17}^{(1)} & M_{18}^{(1)} & 0 & 0 & 0 & 0 \\ M_{21}^{(1)} & M_{22}^{(1)} & M_{23}^{(1)} & M_{24}^{(1)} & M_{25}^{(1)} & M_{26}^{(1)} & M_{27}^{(1)} & M_{28}^{(1)} & 0 & 0 & 0 & 0 \\ M_{31}^{(1)} & M_{32}^{(1)} & M_{33}^{(1)} & M_{34}^{(1)} & M_{35}^{(1)} & M_{36}^{(1)} & M_{37}^{(1)} & M_{38}^{(1)} & 0 & 0 & 0 & 0 \\ M_{41}^{(1)} & M_{42}^{(1)} & M_{43}^{(1)} & M_{44}^{(1)} & M_{45}^{(1)} & M_{46}^{(1)} & M_{47}^{(1)} & M_{48}^{(1)} & 0 & 0 & 0 & 0 \\ M_{51}^{(1)} & M_{52}^{(1)} & M_{53}^{(1)} & M_{54}^{(1)} & M_{55}^{(1)} & M_{56}^{(1)} & M_{57}^{(1)} & M_{58}^{(1)} & 0 & 0 & 0 & 0 \\ M_{61}^{(1)} & M_{62}^{(1)} & M_{63}^{(1)} & M_{64}^{(1)} & M_{65}^{(1)} & M_{66}^{(1)} & M_{67}^{(1)} & M_{68}^{(1)} & 0 & 0 & 0 & 0 \\ M_{71}^{(1)} & M_{72}^{(1)} & M_{73}^{(1)} & M_{74}^{(1)} & M_{75}^{(1)} & M_{76}^{(1)} & M_{77}^{(1)} & M_{78}^{(1)} & 0 & 0 & 0 & 0 \\ M_{81}^{(1)} & M_{82}^{(1)} & M_{83}^{(1)} & M_{84}^{(1)} & M_{85}^{(1)} & M_{86}^{(1)} & M_{87}^{(1)} & M_{88}^{(1)} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{array} \right] \begin{matrix} T_1 \\ T_2 \\ T_3 \\ T_4 \\ T_5 \\ T_6 \\ T_7 \\ T_8 \\ T_9 \\ T_{10} \\ T_{11} \\ T_{12} \end{matrix} \end{matrix} = \begin{matrix} \left[\begin{array}{c} q_1^{(1)} \\ q_2^{(1)} \\ q_3^{(1)} \\ q_4^{(1)} \\ q_5^{(1)} \\ q_6^{(1)} \\ q_7^{(1)} \\ q_8^{(1)} \\ 0 \\ 0 \\ 0 \\ 0 \end{array} \right] + \begin{matrix} \left[\begin{array}{c} Q_1^{(1)} \\ Q_2^{(1)} \\ Q_3^{(1)} \\ Q_4^{(1)} \\ Q_5^{(1)} \\ Q_6^{(1)} \\ Q_7^{(1)} \\ Q_8^{(1)} \\ 0 \\ 0 \\ 0 \\ 0 \end{array} \right] \end{matrix}
 \end{matrix}$$

+



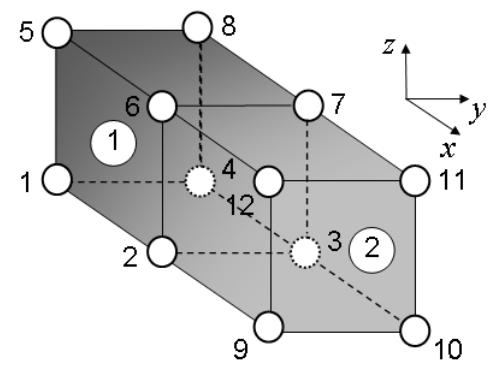
$$\begin{matrix} k \\ \left[\begin{array}{cccccccccccc} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & M_{22}^{(2)} & M_{23}^{(2)} & 0 & 0 & M_{26}^{(2)} & M_{27}^{(2)} & 0 & M_{29}^{(2)} & M_{210}^{(2)} & M_{211}^{(2)} & M_{212}^{(2)} \\ 0 & M_{32}^{(2)} & M_{33}^{(2)} & 0 & 0 & M_{36}^{(2)} & M_{37}^{(2)} & 0 & M_{39}^{(2)} & M_{310}^{(2)} & M_{311}^{(2)} & M_{312}^{(2)} \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & M_{62}^{(2)} & M_{63}^{(2)} & 0 & 0 & M_{66}^{(2)} & M_{67}^{(2)} & 0 & M_{69}^{(2)} & M_{610}^{(2)} & M_{611}^{(2)} & M_{612}^{(2)} \\ 0 & M_{72}^{(2)} & M_{73}^{(2)} & 0 & 0 & M_{76}^{(2)} & M_{77}^{(2)} & 0 & M_{79}^{(2)} & M_{710}^{(2)} & M_{711}^{(2)} & M_{712}^{(2)} \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & M_{92}^{(2)} & M_{93}^{(2)} & 0 & 0 & M_{96}^{(2)} & M_{97}^{(2)} & 0 & M_{99}^{(2)} & M_{910}^{(2)} & M_{911}^{(2)} & M_{912}^{(2)} \\ 0 & M_{102}^{(2)} & M_{103}^{(2)} & 0 & 0 & M_{106}^{(2)} & M_{107}^{(2)} & 0 & M_{109}^{(2)} & M_{1010}^{(2)} & M_{1011}^{(2)} & M_{1012}^{(2)} \\ 0 & M_{112}^{(2)} & M_{113}^{(2)} & 0 & 0 & M_{116}^{(2)} & M_{117}^{(2)} & 0 & M_{119}^{(2)} & M_{1110}^{(2)} & M_{1111}^{(2)} & M_{1112}^{(2)} \\ 0 & M_{122}^{(2)} & M_{123}^{(2)} & 0 & 0 & M_{126}^{(2)} & M_{127}^{(2)} & 0 & M_{129}^{(2)} & M_{1210}^{(2)} & M_{1211}^{(2)} & M_{1212}^{(2)} \end{array} \right] \begin{matrix} T_1 \\ T_2 \\ T_3 \\ T_4 \\ T_5 \\ T_6 \\ T_7 \\ T_8 \\ T_9 \\ T_{10} \\ T_{11} \\ T_{12} \end{matrix} \end{matrix} = \begin{matrix} \left[\begin{array}{c} 0 \\ q_2^{(2)} \\ q_3^{(2)} \\ 0 \\ 0 \\ q_6^{(2)} \\ q_7^{(2)} \\ 0 \\ q_9^{(2)} \\ q_{10}^{(2)} \\ q_{11}^{(2)} \\ q_{12}^{(2)} \end{array} \right] + \begin{matrix} \left[\begin{array}{c} 0 \\ Q_2^{(2)} \\ Q_3^{(2)} \\ 0 \\ 0 \\ Q_6^{(2)} \\ Q_7^{(2)} \\ 0 \\ Q_9^{(2)} \\ Q_{10}^{(2)} \\ Q_{11}^{(2)} \\ Q_{12}^{(2)} \end{array} \right] \end{matrix}
 \end{matrix}$$

=

• sistem enačb za celotni problem

$$\begin{matrix} k \\ \left[\begin{array}{cccccccccccc} M_{11}^{(1)} & M_{12}^{(1)} & M_{13}^{(1)} & M_{14}^{(1)} & M_{15}^{(1)} & M_{16}^{(1)} & M_{17}^{(1)} & M_{18}^{(1)} & 0 & 0 & 0 & 0 \\ M_{21}^{(1)} & M_{22}^{(1)} + M_{22}^{(2)} & M_{23}^{(1)} + M_{23}^{(2)} & M_{24}^{(1)} & M_{25}^{(1)} & M_{26}^{(1)} + M_{26}^{(2)} & M_{27}^{(1)} + M_{27}^{(2)} & M_{28}^{(1)} & M_{29}^{(2)} & M_{210}^{(2)} & M_{211}^{(2)} & M_{212}^{(2)} \\ M_{31}^{(1)} & M_{32}^{(1)} + M_{32}^{(2)} & M_{33}^{(1)} + M_{33}^{(2)} & M_{34}^{(1)} & M_{35}^{(1)} & M_{36}^{(1)} + M_{36}^{(2)} & M_{37}^{(1)} + M_{37}^{(2)} & M_{38}^{(1)} & M_{39}^{(2)} & M_{310}^{(2)} & M_{311}^{(2)} & M_{312}^{(2)} \\ M_{41}^{(1)} & M_{42}^{(1)} & M_{43}^{(1)} & M_{44}^{(1)} & M_{45}^{(1)} & M_{46}^{(1)} & M_{47}^{(1)} & M_{48}^{(1)} & 0 & 0 & 0 & 0 \\ M_{51}^{(1)} & M_{52}^{(1)} & M_{53}^{(1)} & M_{54}^{(1)} & M_{55}^{(1)} & M_{56}^{(1)} & M_{57}^{(1)} & M_{58}^{(1)} & 0 & 0 & 0 & 0 \\ M_{61}^{(1)} & M_{62}^{(1)} + M_{62}^{(2)} & M_{63}^{(1)} + M_{63}^{(2)} & M_{64}^{(1)} & M_{65}^{(1)} & M_{66}^{(1)} + M_{66}^{(2)} & M_{67}^{(1)} + M_{67}^{(2)} & M_{68}^{(1)} & M_{69}^{(2)} & M_{610}^{(2)} & M_{611}^{(2)} & M_{612}^{(2)} \\ M_{71}^{(1)} & M_{72}^{(1)} + M_{72}^{(2)} & M_{73}^{(1)} + M_{73}^{(2)} & M_{74}^{(1)} & M_{75}^{(1)} & M_{76}^{(1)} + M_{76}^{(2)} & M_{77}^{(1)} + M_{77}^{(2)} & M_{78}^{(1)} & M_{79}^{(2)} & M_{710}^{(2)} & M_{711}^{(2)} & M_{712}^{(2)} \\ M_{81}^{(1)} & M_{82}^{(1)} & M_{83}^{(1)} & M_{84}^{(1)} & M_{85}^{(1)} & M_{86}^{(1)} & M_{87}^{(1)} & M_{88}^{(1)} & 0 & 0 & 0 & 0 \\ 0 & M_{92}^{(2)} & M_{93}^{(2)} & 0 & 0 & M_{96}^{(2)} & M_{97}^{(2)} & 0 & M_{99}^{(2)} & M_{910}^{(2)} & M_{911}^{(2)} & M_{912}^{(2)} \\ 0 & M_{102}^{(2)} & M_{103}^{(2)} & 0 & 0 & M_{106}^{(2)} & M_{107}^{(2)} & 0 & M_{109}^{(2)} & M_{1010}^{(2)} & M_{1011}^{(2)} & M_{1012}^{(2)} \\ 0 & M_{112}^{(2)} & M_{113}^{(2)} & 0 & 0 & M_{116}^{(2)} & M_{117}^{(2)} & 0 & M_{119}^{(2)} & M_{1110}^{(2)} & M_{1111}^{(2)} & M_{1112}^{(2)} \\ 0 & M_{122}^{(2)} & M_{123}^{(2)} & 0 & 0 & M_{126}^{(2)} & M_{127}^{(2)} & 0 & M_{129}^{(2)} & M_{1210}^{(2)} & M_{1211}^{(2)} & M_{1212}^{(2)} \end{array} \right] \begin{matrix} T_1 \\ T_2 \\ T_3 \\ T_4 \\ T_5 \\ T_6 \\ T_7 \\ T_8 \\ T_9 \\ T_{10} \\ T_{11} \\ T_{12} \end{matrix} \right\} = \left\{ \begin{matrix} q_1^{(1)} \\ q_2^{(1)} + q_2^{(2)} \\ q_3^{(1)} + q_3^{(2)} \\ q_4^{(1)} \\ q_5^{(1)} \\ q_6^{(1)} + q_6^{(2)} \\ q_7^{(1)} + q_7^{(2)} \\ q_8^{(1)} \\ q_9^{(2)} \\ q_{10}^{(2)} \\ q_{11}^{(2)} \\ q_{12}^{(2)} \end{matrix} \right\} + \left\{ \begin{matrix} Q_1^{(1)} \\ Q_2^{(1)} + Q_2^{(2)} \\ Q_3^{(1)} + Q_3^{(2)} \\ Q_4^{(1)} \\ Q_5^{(1)} \\ Q_6^{(1)} + Q_6^{(2)} \\ Q_7^{(1)} + Q_7^{(2)} \\ Q_8^{(1)} \\ Q_9^{(2)} \\ Q_{10}^{(2)} \\ Q_{11}^{(2)} \\ Q_{12}^{(2)} \end{matrix} \right\}
 \end{matrix}$$

$$k [M_k] \{T\} = \{q_q\} + \{q_Q\}$$

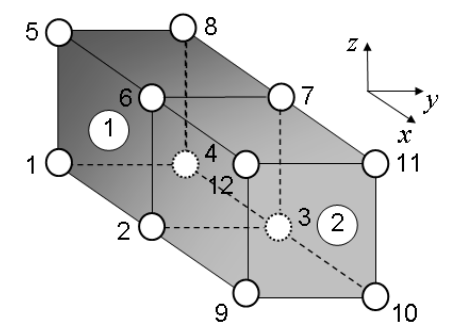


• matrika prevodnosti za celotni problem

$k [M_k] = k$

$M_{1 1}^{(1)}$	$M_{1 2}^{(1)}$	$M_{1 3}^{(1)}$	$M_{1 4}^{(1)}$	$M_{1 5}^{(1)}$	$M_{1 6}^{(1)}$	$M_{1 7}^{(1)}$	$M_{1 8}^{(1)}$	0	0	0	0
$M_{2 1}^{(1)}$	$M_{2 2}^{(1)} + M_{2 2}^{(2)}$	$M_{2 3}^{(1)} + M_{2 3}^{(2)}$	$M_{2 4}^{(1)}$	$M_{2 5}^{(1)}$	$M_{2 6}^{(1)} + M_{2 6}^{(2)}$	$M_{2 7}^{(1)} + M_{2 7}^{(2)}$	$M_{2 8}^{(1)}$	$M_{2 9}^{(2)}$	$M_{2 10}^{(2)}$	$M_{2 11}^{(2)}$	$M_{2 12}^{(2)}$
$M_{3 1}^{(1)}$	$M_{3 2}^{(1)} + M_{3 2}^{(2)}$	$M_{3 3}^{(1)} + M_{3 3}^{(2)}$	$M_{3 4}^{(1)}$	$M_{3 5}^{(1)}$	$M_{3 6}^{(1)} + M_{3 6}^{(2)}$	$M_{3 7}^{(1)} + M_{3 7}^{(2)}$	$M_{3 8}^{(1)}$	$M_{3 9}^{(2)}$	$M_{3 10}^{(2)}$	$M_{3 11}^{(2)}$	$M_{3 12}^{(2)}$
$M_{4 1}^{(1)}$	$M_{4 2}^{(1)}$	$M_{4 3}^{(1)}$	$M_{4 4}^{(1)}$	$M_{4 5}^{(1)}$	$M_{4 6}^{(1)}$	$M_{4 7}^{(1)}$	$M_{4 8}^{(1)}$	0	0	0	0
$M_{5 1}^{(1)}$	$M_{5 2}^{(1)}$	$M_{5 3}^{(1)}$	$M_{5 4}^{(1)}$	$M_{5 5}^{(1)}$	$M_{5 6}^{(1)}$	$M_{5 7}^{(1)}$	$M_{5 8}^{(1)}$	0	0	0	0
$M_{6 1}^{(1)}$	$M_{6 2}^{(1)} + M_{6 2}^{(2)}$	$M_{6 3}^{(1)} + M_{6 3}^{(2)}$	$M_{6 4}^{(1)}$	$M_{6 5}^{(1)}$	$M_{6 6}^{(1)} + M_{6 6}^{(2)}$	$M_{6 7}^{(1)} + M_{6 7}^{(2)}$	$M_{6 8}^{(1)}$	$M_{6 9}^{(2)}$	$M_{6 10}^{(2)}$	$M_{6 11}^{(2)}$	$M_{6 12}^{(2)}$
$M_{7 1}^{(1)}$	$M_{7 2}^{(1)} + M_{7 2}^{(2)}$	$M_{7 3}^{(1)} + M_{7 3}^{(2)}$	$M_{7 4}^{(1)}$	$M_{7 5}^{(1)}$	$M_{7 6}^{(1)} + M_{7 6}^{(2)}$	$M_{7 7}^{(1)} + M_{7 7}^{(2)}$	$M_{7 8}^{(1)}$	$M_{7 9}^{(2)}$	$M_{7 10}^{(2)}$	$M_{7 11}^{(2)}$	$M_{7 12}^{(2)}$
$M_{8 1}^{(1)}$	$M_{8 2}^{(1)}$	$M_{8 3}^{(1)}$	$M_{8 4}^{(1)}$	$M_{8 5}^{(1)}$	$M_{8 6}^{(1)}$	$M_{8 7}^{(1)}$	$M_{8 8}^{(1)}$	0	0	0	0
0	$M_{9 2}^{(2)}$	$M_{9 3}^{(2)}$	0	0	$M_{9 6}^{(2)}$	$M_{9 7}^{(2)}$	0	$M_{9 9}^{(2)}$	$M_{9 10}^{(2)}$	$M_{9 11}^{(2)}$	$M_{9 12}^{(2)}$
0	$M_{10 2}^{(2)}$	$M_{10 3}^{(2)}$	0	0	$M_{10 6}^{(2)}$	$M_{10 7}^{(2)}$	0	$M_{10 9}^{(2)}$	$M_{10 10}^{(2)}$	$M_{10 11}^{(2)}$	$M_{10 12}^{(2)}$
0	$M_{11 2}^{(2)}$	$M_{11 3}^{(2)}$	0	0	$M_{11 6}^{(2)}$	$M_{11 7}^{(2)}$	0	$M_{11 9}^{(2)}$	$M_{11 10}^{(2)}$	$M_{11 11}^{(2)}$	$M_{11 12}^{(2)}$
0	$M_{12 2}^{(2)}$	$M_{12 3}^{(2)}$	0	0	$M_{12 6}^{(2)}$	$M_{12 7}^{(2)}$	0	$M_{12 9}^{(2)}$	$M_{12 10}^{(2)}$	$M_{12 11}^{(2)}$	$M_{12 12}^{(2)}$

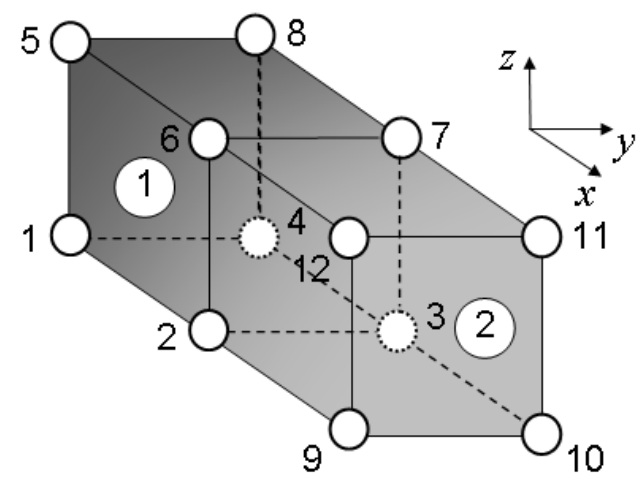
$$M_{IJ}^{(ke)} = \int_{-1}^{+1} \int_{-1}^{+1} \int_{-1}^{+1} \left\{ \tilde{F}_{xI} \tilde{F}_{xJ} + \tilde{F}_{yI} \tilde{F}_{yJ} + \tilde{F}_{zI} \tilde{F}_{zJ} \right\} |J^{(ke)}| d\tilde{x} d\tilde{y} d\tilde{z}$$



- iz podane volumsko dovodene/odvedene toplote izračunane ekvivalentne vrednosti vozliščnega izvora/ponora toplote

$$\{q_Q\} = \left\{ \begin{array}{l} Q_1^{(1)} \\ Q_2^{(1)} + Q_2^{(2)} \\ Q_3^{(1)} + Q_3^{(2)} \\ Q_4^{(1)} \\ Q_5^{(1)} \\ Q_6^{(1)} + Q_6^{(2)} \\ Q_7^{(1)} + Q_7^{(2)} \\ Q_8^{(1)} \\ Q_9^{(2)} \\ Q_{10}^{(2)} \\ Q_{11}^{(2)} \\ Q_{12}^{(2)} \end{array} \right\}$$

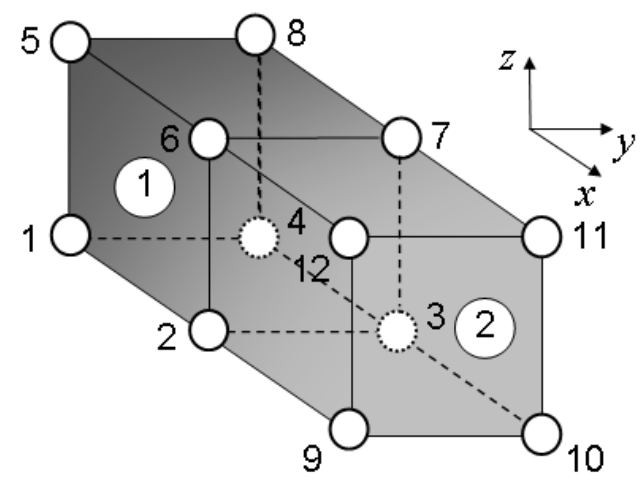
$$Q_I^{(ke)} = \int_{-1}^{+1} \int_{-1}^{+1} \int_{-1}^{+1} Q^{(ke)} \tilde{\psi}_I \left| J^{(ke)} \right| d\tilde{x} d\tilde{y} d\tilde{z}$$



- iz površinskega toplotnega toka izračunane ekvivalentne vrednosti vozliščnega izvora/ponora toplote

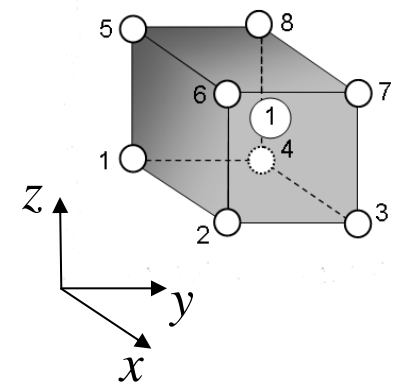
$$\{q_q\} = \left\{ \begin{array}{l} q_1^{(1)} \\ q_2^{(1)} + q_2^{(2)} \\ q_3^{(1)} + q_3^{(2)} \\ q_4^{(1)} \\ q_5^{(1)} \\ q_6^{(1)} + q_6^{(2)} \\ q_7^{(1)} + q_7^{(2)} \\ q_8^{(1)} \\ q_9^{(2)} \\ q_{10}^{(2)} \\ q_{11}^{(2)} \\ q_{12}^{(2)} \end{array} \right\}$$

$$q_I^{(ke)} = - \int_{\tilde{\Gamma}} [q_x^{(ke)} n_x^{(ke)} + q_y^{(ke)} n_y^{(ke)} + q_z^{(ke)} n_z^{(ke)}] \tilde{\psi}_I |j^{(ke)}| d\tilde{\Gamma}$$



- iz površinskega toplotnega toka izračunane ekvivalentne vrednosti vozliščnega izvora/ponora toplote

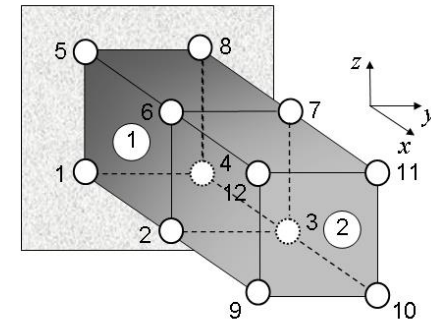
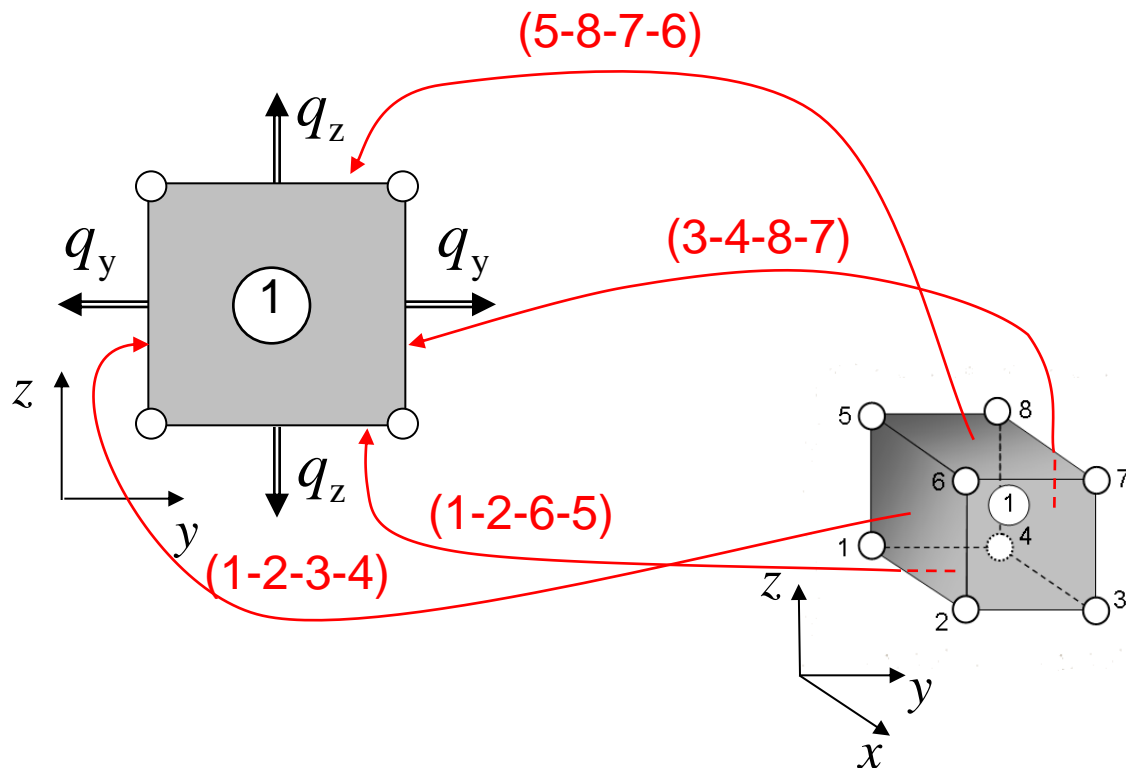
$$\begin{aligned}
 q_I^{(1)} &= - \int_{\tilde{\Gamma}} [q_x^{(1)} n_x^{(1)} + q_y^{(1)} n_y^{(1)} + q_z^{(1)} n_z^{(1)}] \tilde{\psi}_I |j^{(1)}| d\tilde{\Gamma} = \\
 &= \left\{ - \int_{-1-1}^{+1+1} [q_x 0 + q_y 0 + q_z 1] \tilde{\psi}_I |j^{(1)}| d\tilde{x} d\tilde{y} \right\}_{\tilde{z}=+1} + \left\{ - \int_{-1-1}^{+1+1} [q_x 0 + q_y 0 + q_z 1] \tilde{\psi}_I |j^{(1)}| d\tilde{x} d\tilde{y} \right\}_{\tilde{z}=-1} + \\
 &+ \left\{ - \int_{-1-1}^{+1+1} [q_x 0 + q_y 1 + q_z 0] \tilde{\psi}_I |j^{(1)}| d\tilde{x} d\tilde{z} \right\}_{\tilde{y}=+1} + \left\{ - \int_{-1-1}^{+1+1} [q_x 0 + q_y 1 + q_z 0] \tilde{\psi}_I |j^{(1)}| d\tilde{x} d\tilde{z} \right\}_{\tilde{y}=-1} + \\
 &+ \left\{ - \int_{-1-1}^{+1+1} [q_x 1 + q_y 0 + q_z 0] \tilde{\psi}_I |j^{(1)}| d\tilde{y} d\tilde{z} \right\}_{\tilde{x}=+1} + \left\{ - \int_{-1-1}^{+1+1} [q_x 1 + q_y 0 + q_z 0] \tilde{\psi}_I |j^{(1)}| d\tilde{y} d\tilde{z} \right\}_{\tilde{x}=-1} = \\
 &= \left\{ - \int_{-1-1}^{+1+1} q_z \tilde{\psi}_I |j^{(1)}| d\tilde{x} d\tilde{y} \right\}_{\tilde{z}=+1} + \left\{ - \int_{-1-1}^{+1+1} q_z \tilde{\psi}_I |j^{(1)}| d\tilde{x} d\tilde{y} \right\}_{\tilde{z}=-1} + \\
 &+ \left\{ - \int_{-1-1}^{+1+1} q_y \tilde{\psi}_I |j^{(1)}| d\tilde{x} d\tilde{z} \right\}_{\tilde{y}=+1} + \left\{ - \int_{-1-1}^{+1+1} q_y \tilde{\psi}_I |j^{(1)}| d\tilde{x} d\tilde{z} \right\}_{\tilde{y}=-1} + \\
 &+ \left\{ - \int_{-1-1}^{+1+1} q_x \tilde{\psi}_I |j^{(1)}| d\tilde{y} d\tilde{z} \right\}_{\tilde{x}=+1} + \left\{ - \int_{-1-1}^{+1+1} q_x \tilde{\psi}_I |j^{(1)}| d\tilde{y} d\tilde{z} \right\}_{\tilde{x}=-1}
 \end{aligned}$$



- na površini KE, ki sovпада s površino na kateri se odvija prenos toplote zaradi naravne konvekcije zraka, je toplotni tok določen z enačbo

$$q_n = h_{zrak} (T - T_{zrak})$$

- proste površine KE izpostavljene prenosu toplote zaradi konvekcije



- izračun ekvivalentnega vozliščnega toplotnega izvora/ponora kot posledica prenosa toplote s konvekcijo s proste površine KE

$$\begin{aligned}
 & \left\{ - \int_{-1}^{+1} \int_{-1}^{+1} q_z \tilde{\psi}_I |j^{(1)}| d\tilde{x} d\tilde{y} \right\}_{\tilde{z}=+1} = \\
 & = -h_{\text{zrak}} \int_{-1}^{+1} \int_{-1}^{+1} (\tilde{T}(\tilde{x}, \tilde{y}, \tilde{z} = +1) - T_{\text{zrak}}) \tilde{\psi}_I |j^{(1)}| d\tilde{x} d\tilde{y} = \\
 & = -h_{\text{zrak}} \int_{-1}^{+1} \int_{-1}^{+1} \left(\sum_{j=1}^{N_v} T_j \tilde{\psi}_j(\tilde{x}, \tilde{y}, \tilde{z} = +1) - T_{\text{zrak}} \right) \tilde{\psi}_I |j^{(1)}| d\tilde{x} d\tilde{y} = \\
 & = -h_{\text{zrak}} \int_{-1}^{+1} \int_{-1}^{+1} \left(\sum_{j=1}^{N_v} T_j \tilde{\psi}_j(\tilde{x}, \tilde{y}, \tilde{z} = +1) \right) \tilde{\psi}_I |j^{(1)}| d\tilde{x} d\tilde{y} + h_{\text{zrak}} T_{\text{zrak}} \int_{-1}^{+1} \int_{-1}^{+1} \tilde{\psi}_I |j^{(1)}| d\tilde{x} d\tilde{y}
 \end{aligned}$$

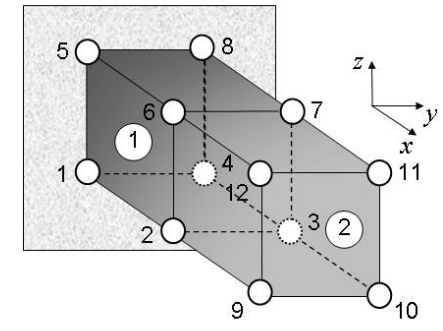
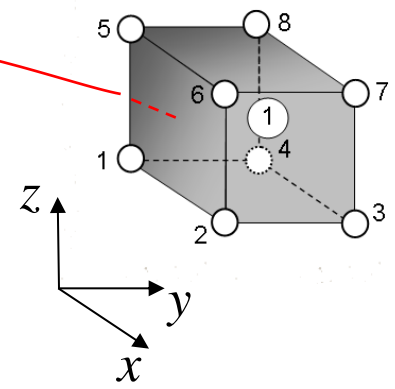
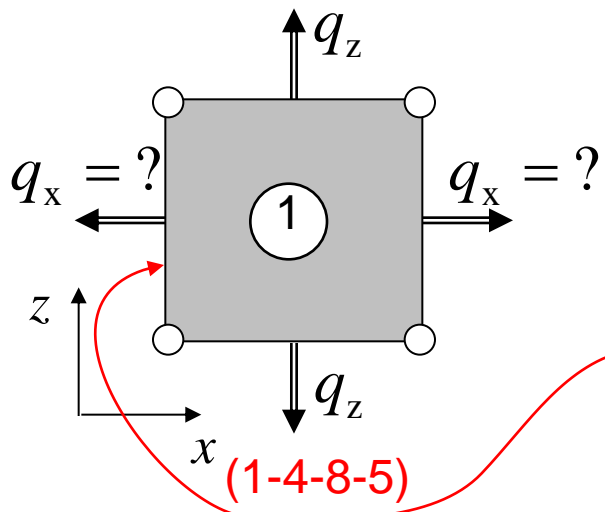
- izračun ekvivalentnega vozliščnega toplotnega izvora/ponora kot posledica prenosa toplote s konvekcijo s proste površine KE, upoštevajoč vse proste površine na KE številka 1

$$\begin{aligned}
 & \left\{ - \int_{-1}^{+1} \int_{-1}^{+1} q_z \tilde{\psi}_I |j^{(1)}| d\tilde{x} d\tilde{y} \right\}_{\tilde{z}=+1} + \left\{ - \int_{-1}^{+1} \int_{-1}^{+1} q_z \tilde{\psi}_I |j^{(1)}| d\tilde{x} d\tilde{y} \right\}_{\tilde{z}=-1} + \\
 & + \left\{ - \int_{-1}^{+1} \int_{-1}^{+1} q_y \tilde{\psi}_I |j^{(1)}| d\tilde{x} d\tilde{z} \right\}_{\tilde{y}=+1} + \left\{ - \int_{-1}^{+1} \int_{-1}^{+1} q_y \tilde{\psi}_I |j^{(1)}| d\tilde{x} d\tilde{z} \right\}_{\tilde{y}=-1} = \\
 & = -h_{\text{zrak}} \left[M_h^{(1)} \right] \{T\} + \{q_q^{(1)}\}
 \end{aligned}$$

- na površini KE, ki je v kontaktu s steno, je znana temperatura, medtem ko toplotni tok skozi to površino KE ni znan, tako da ne moremo izračunati ekvivalentnega vozliščnega toplotnega izvora/ponora

$$\{q_T^{(1)}\} = ?$$

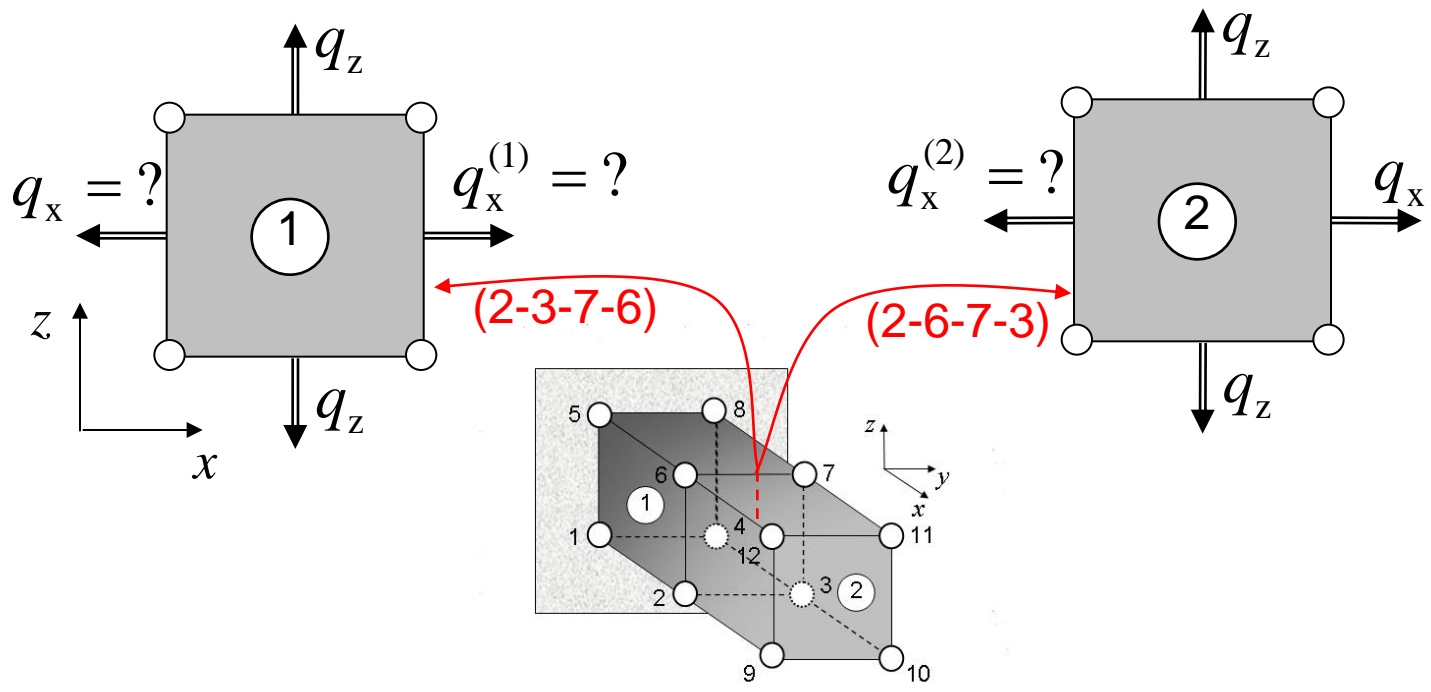
- površina KE, na kateri je znana temperatura



- na površini KE, ki je skupna s sosednjim KE, toplotni tok ni znan, velja pa enakost

$$q_n^{(1)} = -q_n^{(2)}$$

- površina med dvema KE



- enakost

$$q_n^{(1)} = -q_n^{(2)} = q_n$$

predstavlja matematični zapis ohranjanja toplotnega toka skozi skupno površino dveh sosednjih KE

- ko izračunamo ekvivalentni vozliščni toplotni izvor/ponor v odvisnosti od neznanega toplotnega toka q_n skozi skupno površino, ugotovimo

$$\left\{ q_{2-3-7-6}^{(1)} \right\} = - \left\{ q_{2-6-7-3}^{(2)} \right\} \Rightarrow \left\{ q_{2-3-7-6}^{(1)} \right\} + \left\{ q_{2-6-7-3}^{(2)} \right\} = 0$$

- ker to velja na vseh skupnih površinah med sosednjimi KE, se integral po površini KE, ki leži znotraj obravnavanega območja, ne izračunava

- sistem enačb za celotni problem upoštevajoč robne pogoje in volumsko dovedeno/odvedeno toploto zapisan v simbolni matrični obliki

$$\left(k [M_k] + h [M_h] \right) \{T\} = \{q_q\} + \{q_T\} + \{q_Q\}$$

oziroma krajše

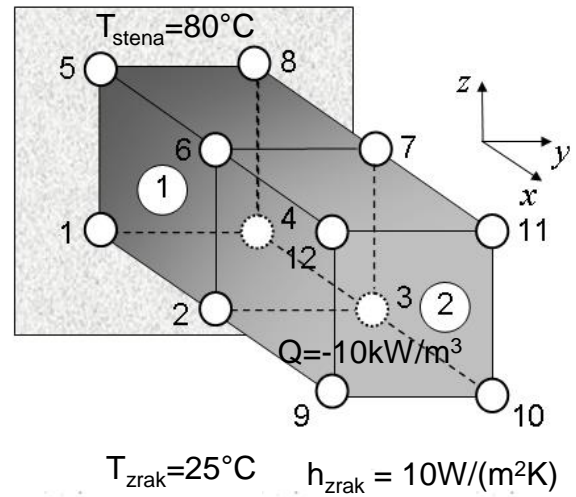
$$[M] \{T\} = \{q\}$$

- za obravnavani toplotni problem smo tako dobili sistem 12 enačb, v katerih imamo 24 neznanih veličin

$$\begin{bmatrix}
 M_{1|1} & M_{1|2} & M_{1|3} & M_{1|4} & M_{1|5} & M_{1|6} & M_{1|7} & M_{1|8} & 0 & 0 & 0 & 0 \\
 M_{2|1} & M_{2|2} & M_{2|3} & M_{2|4} & M_{2|5} & M_{2|6} & M_{2|7} & M_{2|8} & M_{2|9} & M_{2|10} & M_{2|11} & M_{2|12} \\
 M_{3|1} & M_{3|2} & M_{3|3} & M_{3|4} & M_{3|5} & M_{3|6} & M_{3|7} & M_{3|8} & M_{3|9} & M_{3|10} & M_{3|11} & M_{3|12} \\
 M_{4|1} & M_{4|2} & M_{4|3} & M_{4|4} & M_{4|5} & M_{4|6} & M_{4|7} & M_{4|8} & 0 & 0 & 0 & 0 \\
 M_{5|1} & M_{5|2} & M_{5|3} & M_{5|4} & M_{5|5} & M_{5|6} & M_{5|7} & M_{5|8} & 0 & 0 & 0 & 0 \\
 M_{6|1} & M_{6|2} & M_{6|3} & M_{6|4} & M_{6|5} & M_{6|6} & M_{6|7} & M_{6|8} & M_{6|9} & M_{6|10} & M_{6|11} & M_{6|12} \\
 M_{7|1} & M_{7|2} & M_{7|3} & M_{7|4} & M_{7|5} & M_{7|6} & M_{7|7} & M_{7|8} & M_{7|9} & M_{7|10} & M_{7|11} & M_{7|12} \\
 M_{8|1} & M_{8|2} & M_{8|3} & M_{8|4} & M_{8|5} & M_{8|6} & M_{8|7} & M_{8|8} & 0 & 0 & 0 & 0 \\
 0 & M_{9|2} & M_{9|3} & 0 & 0 & M_{9|6} & M_{9|7} & 0 & M_{9|9} & M_{9|10} & M_{9|11} & M_{9|12} \\
 0 & M_{10|2} & M_{10|3} & 0 & 0 & M_{10|6} & M_{10|7} & 0 & M_{10|9} & M_{10|10} & M_{10|11} & M_{10|12} \\
 0 & M_{11|2} & M_{11|3} & 0 & 0 & M_{11|6} & M_{11|7} & 0 & M_{11|9} & M_{11|10} & M_{11|11} & M_{11|12} \\
 0 & M_{12|2} & M_{12|3} & 0 & 0 & M_{12|6} & M_{12|7} & 0 & M_{12|9} & M_{12|10} & M_{12|11} & M_{12|12}
 \end{bmatrix}
 \begin{Bmatrix}
 T_1 \\
 T_2 \\
 T_3 \\
 T_4 \\
 T_5 \\
 T_6 \\
 T_7 \\
 T_8 \\
 T_9 \\
 T_{10} \\
 T_{11} \\
 T_{12}
 \end{Bmatrix}
 =
 \begin{Bmatrix}
 q_1 \\
 q_2 \\
 q_3 \\
 q_4 \\
 q_5 \\
 q_6 \\
 q_7 \\
 q_8 \\
 q_9 \\
 q_{10} \\
 q_{11} \\
 q_{12}
 \end{Bmatrix}$$

$$\begin{bmatrix}
 M_{11} & M_{12} & M_{13} & M_{14} & M_{15} & M_{16} & M_{17} & M_{18} & 0 & 0 & 0 & 0 \\
 M_{21} & M_{22} & M_{23} & M_{24} & M_{25} & M_{26} & M_{27} & M_{28} & M_{29} & M_{210} & M_{211} & M_{212} \\
 M_{31} & M_{32} & M_{33} & M_{34} & M_{35} & M_{36} & M_{37} & M_{38} & M_{39} & M_{310} & M_{311} & M_{312} \\
 M_{41} & M_{42} & M_{43} & M_{44} & M_{45} & M_{46} & M_{47} & M_{48} & 0 & 0 & 0 & 0 \\
 M_{51} & M_{52} & M_{53} & M_{54} & M_{55} & M_{56} & M_{57} & M_{58} & 0 & 0 & 0 & 0 \\
 M_{61} & M_{62} & M_{63} & M_{64} & M_{65} & M_{66} & M_{67} & M_{68} & M_{69} & M_{610} & M_{611} & M_{612} \\
 M_{71} & M_{72} & M_{73} & M_{74} & M_{75} & M_{76} & M_{77} & M_{78} & M_{79} & M_{710} & M_{711} & M_{712} \\
 M_{81} & M_{82} & M_{83} & M_{84} & M_{85} & M_{86} & M_{87} & M_{88} & 0 & 0 & 0 & 0 \\
 0 & M_{92} & M_{93} & 0 & 0 & M_{96} & M_{97} & 0 & M_{99} & M_{910} & M_{911} & M_{912} \\
 0 & M_{102} & M_{103} & 0 & 0 & M_{106} & M_{107} & 0 & M_{109} & M_{1010} & M_{1011} & M_{1012} \\
 0 & M_{112} & M_{113} & 0 & 0 & M_{116} & M_{117} & 0 & M_{119} & M_{1110} & M_{1111} & M_{1112} \\
 0 & M_{122} & M_{123} & 0 & 0 & M_{126} & M_{127} & 0 & M_{129} & M_{1210} & M_{1211} & M_{1212}
 \end{bmatrix}
 \begin{Bmatrix}
 T_1 \\
 T_2 \\
 T_3 \\
 T_4 \\
 T_5 \\
 T_6 \\
 T_7 \\
 T_8 \\
 T_9 \\
 T_{10} \\
 T_{11} \\
 T_{12}
 \end{Bmatrix}
 =
 \begin{Bmatrix}
 q_1 \\
 q_2 \\
 q_3 \\
 q_4 \\
 q_5 \\
 q_6 \\
 q_7 \\
 q_8 \\
 q_9 \\
 q_{10} \\
 q_{11} \\
 q_{12}
 \end{Bmatrix}$$

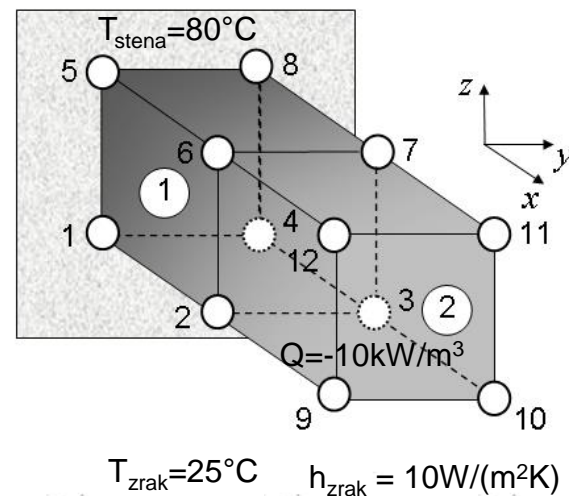
- upoštevani robni pogoji:
 - predpisana temperatura
 - konvekcijski toplotni tok



- upoštevajoč robne pogoje se število neznanih veličin zmanjša na 12

$M_{1 1}$	$M_{1 2}$	$M_{1 3}$	$M_{1 4}$	$M_{1 5}$	$M_{1 6}$	$M_{1 7}$	$M_{1 8}$	0	0	0	0	$T_1 = 80^\circ\text{C}$ $T_2 = ?$ $T_3 = ?$ $T_4 = 80^\circ\text{C}$ $T_5 = 80^\circ\text{C}$ $T_6 = ?$ $T_7 = ?$ $T_8 = 80^\circ\text{C}$ $T_9 = ?$ $T_{10} = ?$ $T_{11} = ?$ $T_{12} = ?$	$q_1 = ?$ q_2 q_3 $q_4 = ?$ $q_5 = ?$ q_6 q_7 $q_8 = ?$ q_9 q_{10} q_{11} q_{12}
$M_{2 1}$	$M_{2 2}$	$M_{2 3}$	$M_{2 4}$	$M_{2 5}$	$M_{2 6}$	$M_{2 7}$	$M_{2 8}$	$M_{2 9}$	$M_{2 10}$	$M_{2 11}$	$M_{2 12}$		
$M_{3 1}$	$M_{3 2}$	$M_{3 3}$	$M_{3 4}$	$M_{3 5}$	$M_{3 6}$	$M_{3 7}$	$M_{3 8}$	$M_{3 9}$	$M_{3 10}$	$M_{3 11}$	$M_{3 12}$		
$M_{4 1}$	$M_{4 2}$	$M_{4 3}$	$M_{4 4}$	$M_{4 5}$	$M_{4 6}$	$M_{4 7}$	$M_{4 8}$	0	0	0	0		
$M_{5 1}$	$M_{5 2}$	$M_{5 3}$	$M_{5 4}$	$M_{5 5}$	$M_{5 6}$	$M_{5 7}$	$M_{5 8}$	0	0	0	0		
$M_{6 1}$	$M_{6 2}$	$M_{6 3}$	$M_{6 4}$	$M_{6 5}$	$M_{6 6}$	$M_{6 7}$	$M_{6 8}$	$M_{6 9}$	$M_{6 10}$	$M_{6 11}$	$M_{6 12}$		
$M_{7 1}$	$M_{7 2}$	$M_{7 3}$	$M_{7 4}$	$M_{7 5}$	$M_{7 6}$	$M_{7 7}$	$M_{7 8}$	$M_{7 9}$	$M_{7 10}$	$M_{7 11}$	$M_{7 12}$		
$M_{8 1}$	$M_{8 2}$	$M_{8 3}$	$M_{8 4}$	$M_{8 5}$	$M_{8 6}$	$M_{8 7}$	$M_{8 8}$	0	0	0	0		
0	$M_{9 2}$	$M_{9 3}$	0	0	$M_{9 6}$	$M_{9 7}$	0	$M_{9 9}$	$M_{9 10}$	$M_{9 11}$	$M_{9 12}$		
0	$M_{10 2}$	$M_{10 3}$	0	0	$M_{10 6}$	$M_{10 7}$	0	$M_{10 9}$	$M_{10 10}$	$M_{10 11}$	$M_{10 12}$		
0	$M_{11 2}$	$M_{11 3}$	0	0	$M_{11 6}$	$M_{11 7}$	0	$M_{11 9}$	$M_{11 10}$	$M_{11 11}$	$M_{11 12}$		
0	$M_{12 2}$	$M_{12 3}$	0	0	$M_{12 6}$	$M_{12 7}$	0	$M_{12 9}$	$M_{12 10}$	$M_{12 11}$	$M_{12 12}$		

- upoštevani robni pogoji:
 - predpisana temperatura
 - konvekcijski toplotni tok



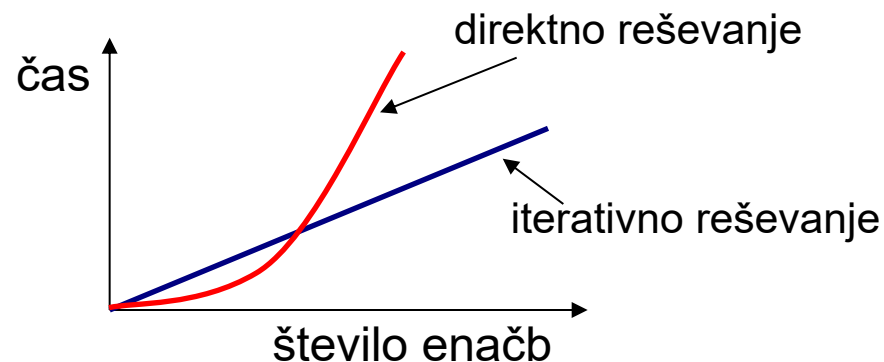
6) reševanje sistema enačb:

▪ direktno reševanje:

- Gaussova eliminacijska metoda s pivotiranjem
- metode z razcepom matrike $[M]$ (metoda Choleskega, LU)

▪ iterativno reševanje

- Gauss-Jacobijeva metoda
- Gauss-Seidlova metoda
- metoda konjugiranih gradientov

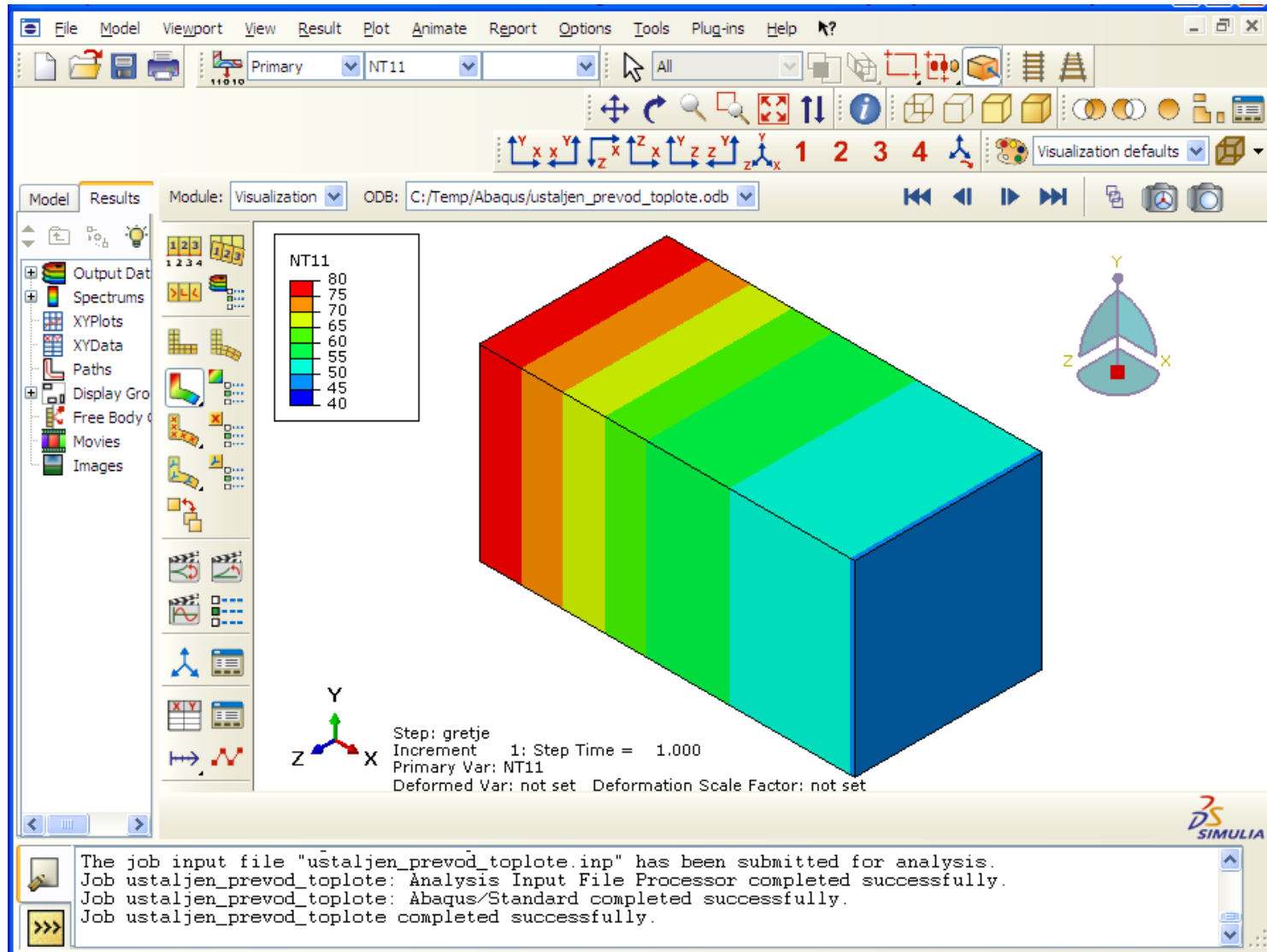


7) prikaz in analiza rezultatov:

- tekstovni prikaz rezultatov
 - v vozliščih KE (primarne veličine)
 - v integracijskih točkah KE (sekundarne veličine)

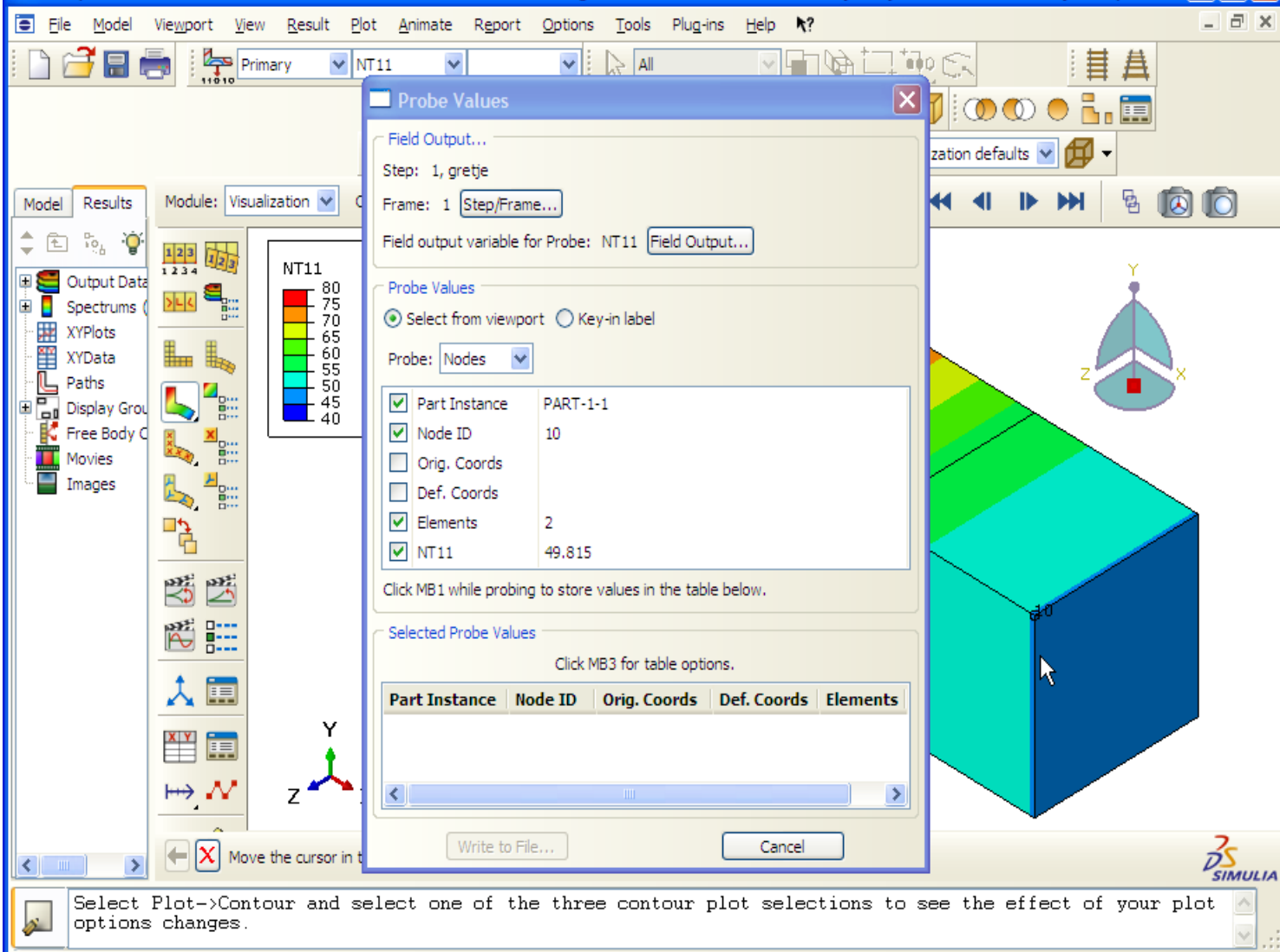
- grafični prikaz rezultatov
 - vektorsko
 - v obliki izolinij

- grafični prikaz rezultatov v obliki izolinij
- temperaturno polje (oznaka v Abaqusu – **NT11**)



- tekstovni prikaz rezultatov

- temperatura v voziščih KE



The screenshot shows a software interface with a 3D model of a part. A color scale legend for 'NT11' is visible, ranging from 40 (blue) to 80 (red). A 'Probe Values' dialog box is open, displaying the following information:

Field Output...
 Step: 1, gretje
 Frame: 1 Step/Frame...
 Field output variable for Probe: NT11 Field Output...

Probe Values
 Select from viewport Key-in label
 Probe: Nodes

<input checked="" type="checkbox"/>	Part Instance	PART-1-1
<input checked="" type="checkbox"/>	Node ID	10
<input type="checkbox"/>	Orig. Coords	
<input type="checkbox"/>	Def. Coords	
<input checked="" type="checkbox"/>	Elements	2
<input checked="" type="checkbox"/>	NT11	49.815

Click MB1 while probing to store values in the table below.

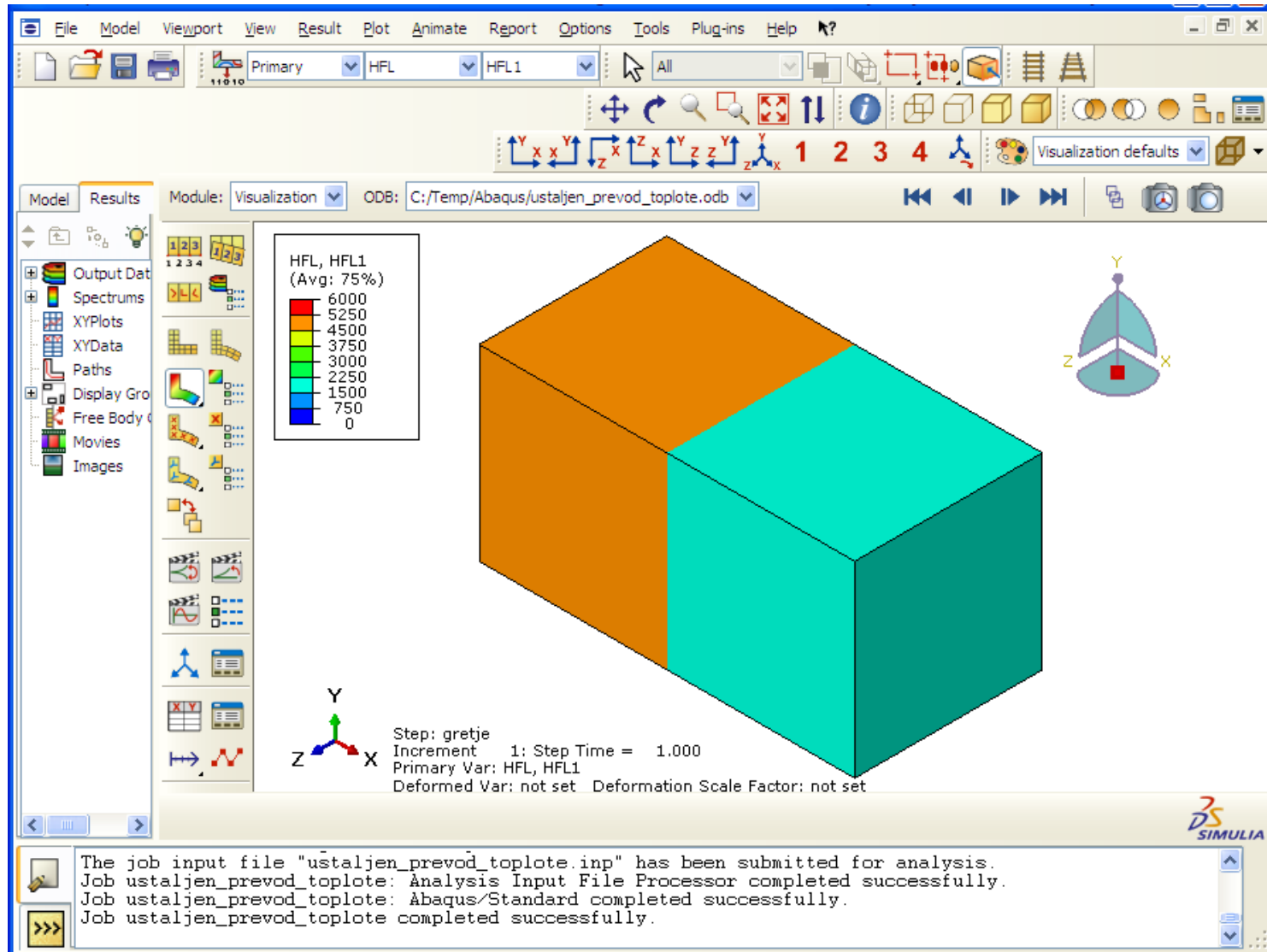
Selected Probe Values
 Click MB3 for table options.

Part Instance	Node ID	Orig. Coords	Def. Coords	Elements
[Empty table body]				

Write to File... Cancel

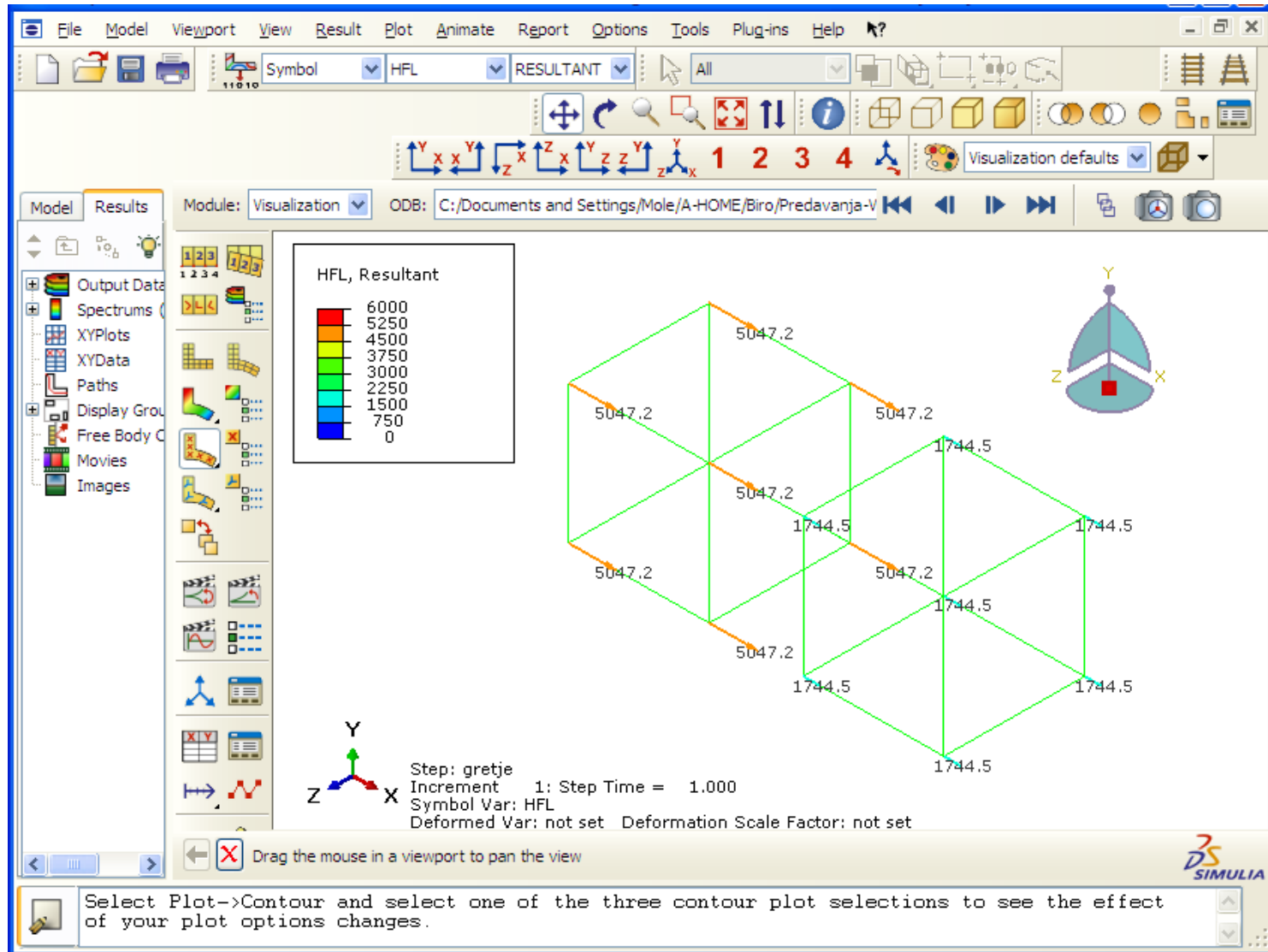
Select Plot->Contour and select one of the three contour plot selections to see the effect of your plot options.

- grafični prikaz rezultatov v obliki izolinij
- toplotni tok v smeri koordinatne osi **x** (oznaka v Abaqusu – **HFL1**)

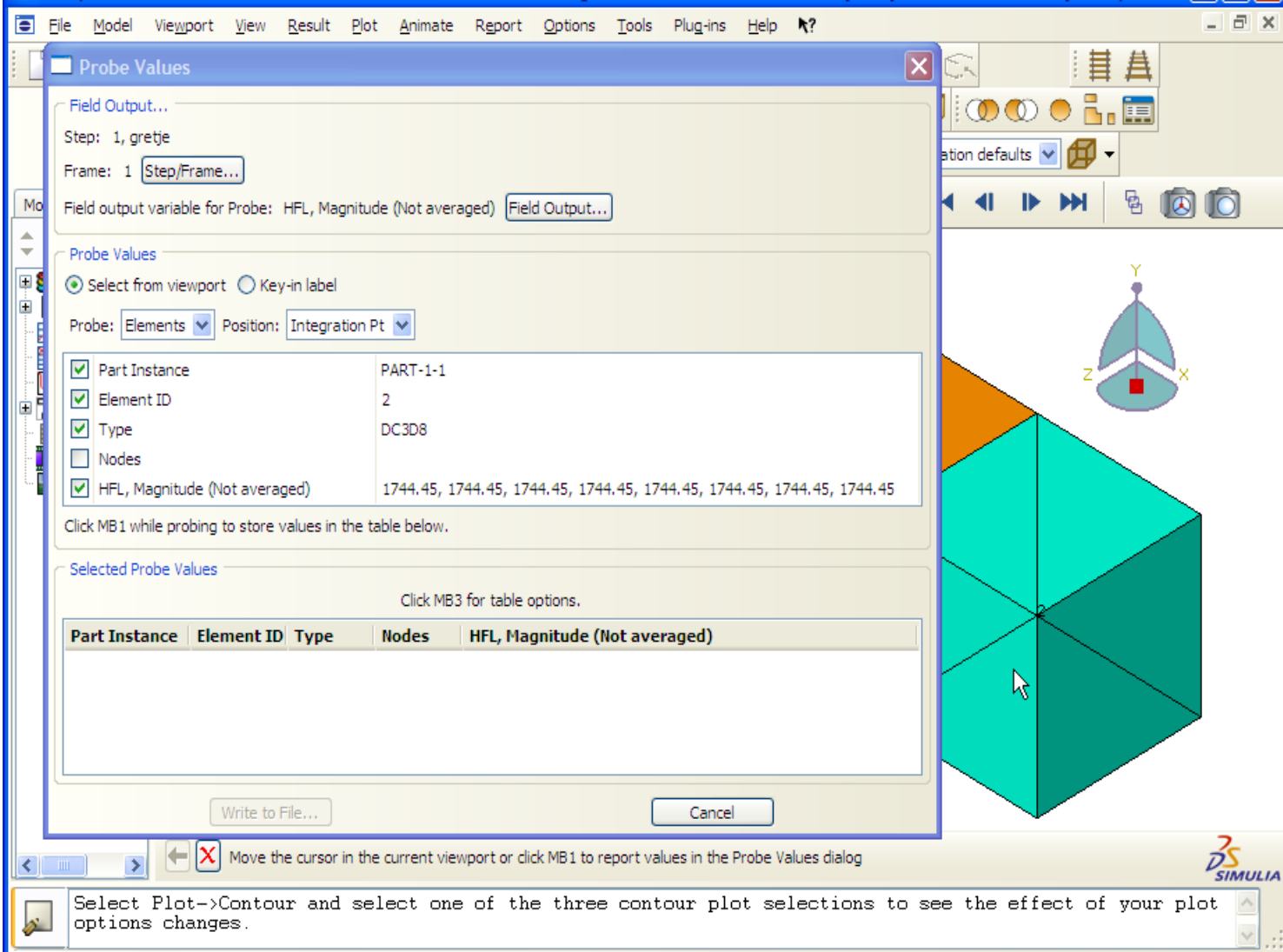


- vektorski grafični prikaz rezultatov

- toplotni tok (oznaka v Abaqusu – **HFL**)



- tekstovni prikaz rezultatov
- toplotni tok v integracijskih točkah KE



Field Output...

Step: 1, gretje

Frame: 1

Field output variable for Probe: HFL, Magnitude (Not averaged)

Probe Values

Select from viewport Key-in label

Probe: Position:

<input checked="" type="checkbox"/> Part Instance	PART-1-1
<input checked="" type="checkbox"/> Element ID	2
<input checked="" type="checkbox"/> Type	DC3D8
<input type="checkbox"/> Nodes	
<input checked="" type="checkbox"/> HFL, Magnitude (Not averaged)	1744.45, 1744.45, 1744.45, 1744.45, 1744.45, 1744.45, 1744.45, 1744.45

Click MB1 while probing to store values in the table below.

Selected Probe Values

Click MB3 for table options.

Part Instance	Element ID	Type	Nodes	HFL, Magnitude (Not averaged)

Move the cursor in the current viewport or click MB1 to report values in the Probe Values dialog

Select Plot->Contour and select one of the three contour plot selections to see the effect of your plot options changes.

7) prikaz in analiza rezultatov:

- enote izračunanih veličin v primeru ustaljenega prevoda toplote

izbrane enote			velikosti vhodnih podatkov			enote izračunanih veličin	
toplotna moč	dolžina	temp.	toplotna prevodnost	toplotna prestopnost	volumska generacija toplote	toplotni tok	toplotni izvor
W	m	K °C	k [W/(m K)]	h [W/(m ² K)]	Q [W/m ³]	W/m²	W
W	mm	K °C	k * 10 ⁻³ [W/(mm K)]	h * 10 ⁻⁶ [W/(mm ² K)]	Q * 10 ⁻⁹ [W/mm ³]	W/mm ²	W
mW	mm	K °C	k [mW/(mm K)]	h * 10 ⁻³ [mW/(mm ² K)]	Q * 10 ⁻⁶ [mW/mm ³]	mW/mm ²	mW
mW	mm	K °C	k * 10 ⁺³ [mW/(mm K)]	h [mW/(mm ² K)]	Q * 10 ⁻³ [mW/mm ³]	mW/mm ²	mW
kW	m	K °C	k * 10 ⁻³ [kW/(m K)]	h * 10 ⁻³ [kW/(m ² K)]	Q * 10 ⁻³ [kW/m ³]	kW/m ²	kW