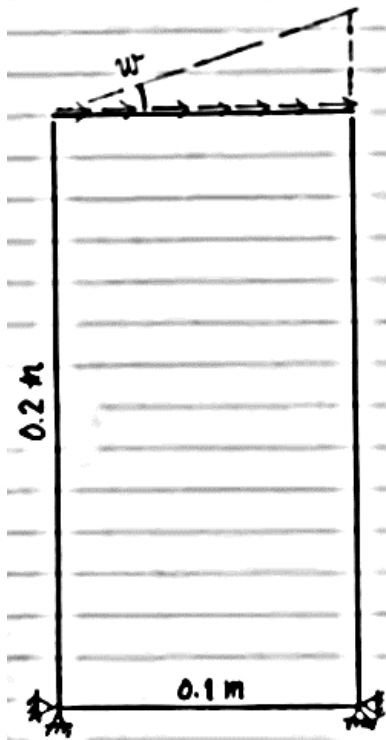


$[k]$: singular, symmetric

$$[K] = \sum_{i=1}^{NE} [k] : \text{symmetric}$$

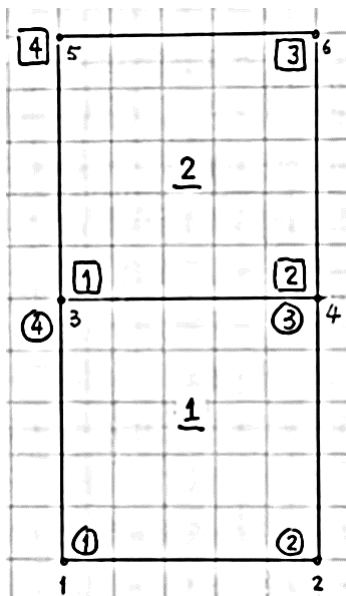
singular before applying B.C.'s



thickness = 5 mm

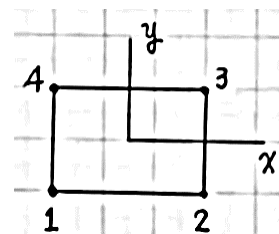
$E = 200 \text{ GPa}$

$\nu = 0.3$



1,1	1,2	1,3	1,4
	2,2	2,3	2,4
		3,3	3,4
symmetry			4,4

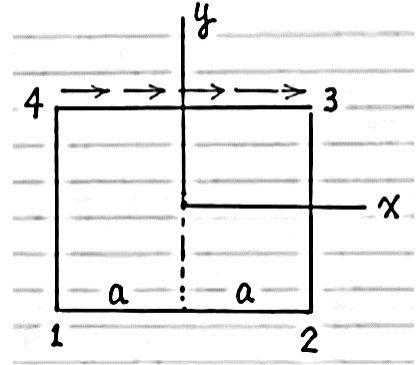
8x8



$$[k] = 10^8 \times$$

$$\begin{bmatrix} 494.51 & 178.57 & -302.20 & -13.736 \\ 178.57 & 494.51 & 13.736 & 54.945 \\ \hdashline 494.51 & -178.57 \\ -178.57 & 494.51 \end{bmatrix}$$

sym.



Surface load on edge "4 - 3":

$$\Phi = \begin{Bmatrix} \Phi_x \\ \Phi_y \end{Bmatrix} = \begin{Bmatrix} \Phi_x \\ 0 \end{Bmatrix}$$

$$\Phi_x = w(x + a)$$

w : force/length³

On the other hand, shape functions are, when evaluated at the edge where $y = b$,

$$\bar{N}_1 = \bar{N}_2 = 0$$

$$\bar{N}_3 = (a + x)/(2a)$$

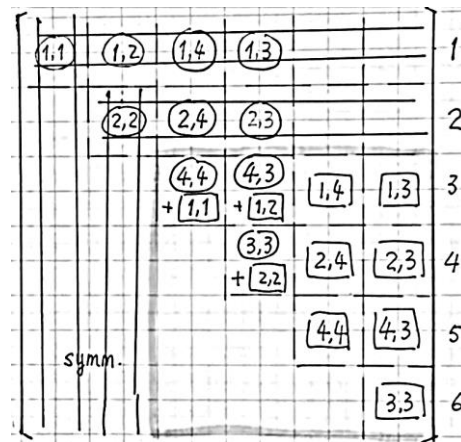
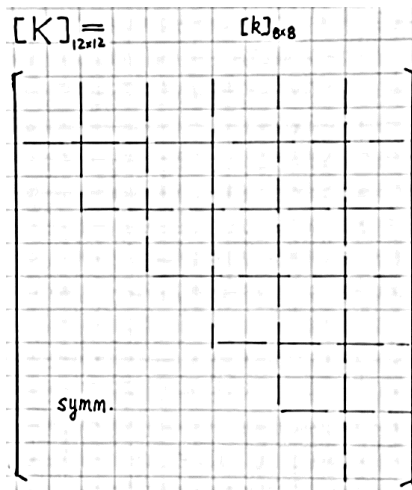
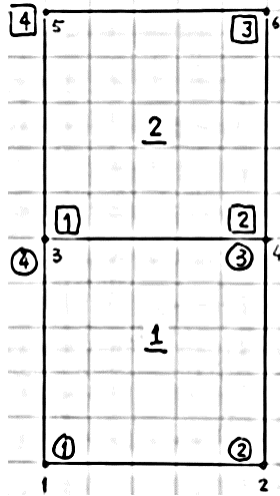
$$\bar{N}_4 = (a - x)/(2a)$$

$$\therefore \{f_{eq}\} = \int_{-a}^a [\bar{N}]^T \{\Phi\} t \, dx$$

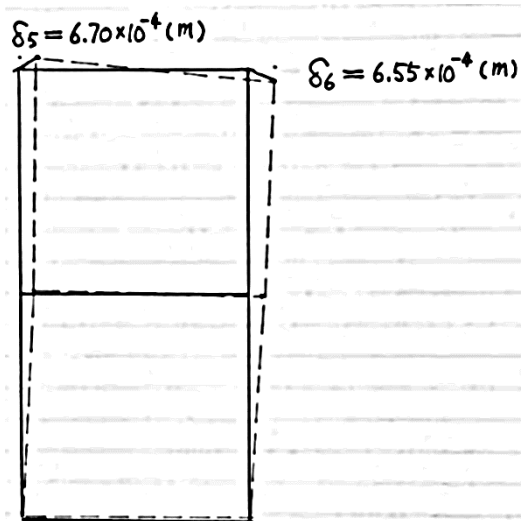
$$[\bar{N}] = \begin{bmatrix} \bar{N}_1 & \bar{N}_2 & \dots & \bar{N}_4 \\ \bar{N}_1 & \bar{N}_2 & \dots & \bar{N}_4 \end{bmatrix}_{2 \times 8}$$

$$\therefore \{f_{eq}\} = \left[0, 0, 0, 0, \frac{4}{3} wta^2, 0, \frac{2}{3} wta^2, 0 \right]^T$$

for element 2



Results:



Stresses at Node 3 & 4 (in MPa):

3	$\begin{Bmatrix} 151.2 \\ 487.4 \\ 201.4 \end{Bmatrix}$	$\begin{Bmatrix} -137.7 \\ -475.6 \\ 189.5 \end{Bmatrix}$	4
	$\begin{Bmatrix} 29.8 \\ 82.4 \\ 166.6 \end{Bmatrix}$	$\begin{Bmatrix} -16.4 \\ -71.0 \\ 168.5 \end{Bmatrix}$	