Fundamental nucleus calculation:

1) Two point gauss quadrature has been taken for the axis of the beam (y)

points = (0.57735, −0.57735) weights = 1, 1

2) Two point gauss quadrature is also considered for the cross section.

point 1 = (0.57735, 0.57735, −0.57735, −0.57735)

point 2 = (0.57735, −0.57735, 0.57735, −0.57735)

weight = [(1).(1), (1).(1), (1).(1), (1).(1)]

3) After that I have taken derivative of the lagrange polynomials with respect to alpha (α) and beta (β)

4) Then I have found $x_{,\alpha}$, $x_{,\beta}$, $y_{,\alpha}$, $y_{,\beta}$ using the formula

~~$x_{,\alpha} = F_1$~~

$$x = F_1 x_1 + F_2 x_2 + F_3 x_3 + F_4 x_4$$

$$x_{,\alpha} = F_{1,\alpha} x_1 + F_{2,\alpha} x_2 + F_{3,\alpha} x_3 + F_{4,\alpha} x_4$$

$\vdots$ $\vdots$

5) After that I have found Jacobian of the cross section using

$$J = (z_{,\beta} * x_{,\alpha} - z_{,\alpha} * x_{,\beta})$$

For my case it is 0.01.

6) Then my code goes into the loop.

for i in (beam nodes) → (3)

for j in (beam nodes):

7) Then it goes into the cross section loop.

for τ in cross section nodes: → (4)

for s in cross section nodes:

8) In the loop first, I ~~d~~ evaluate the values for $F_{\tau,x}$, $F_{\tau,z}$, $F_{s,x}$, $F_{s,z}$.

9) After that ~~FN~~ components of fundamental nucleus are calculated.

Scanned by CamScanner

②

For example:-

$\cancel{K_{xx} = C_{22}\int_A}$

$$K^{1111}_{xx} = C_{22}\int_A F_{1,x}F_{1,x}\,dx\,dz\int_l N_1 N_1\,dy$$

$$+ C_{66}\int_A F_{1,z}F_{1,z}\,dx\,dz\int_l N_1 N_1\,dy$$

$$+ C_{44}\int_A F_1 F_1\,dx\,dz\int_l N_{1,y} N_{1,y}\,dy$$

$J = 0.01 \quad x_{,\alpha} = 0.1 \quad z_{,\alpha} = 0 \quad z_{,\beta} = 0.1 \quad x_{,\beta} = 0$

$$F_{1,x} = \frac{1}{|J|}\left[z_{,\beta} F_{1,\alpha} - z_{,\alpha} F_{1,\beta}\right]$$

$F_{1,x} = -2.5\,[1-\beta] \qquad N_1 = \frac{1}{2}(1-\xi)$

||ly,

$F_{1,z} = 2.5\,[1-\beta)$

∴ the eqn becomes,

$$K^{1111}_{xx} = C_{22}\int_A -2.5(1-\beta)\ast -2.5(1-\beta)\,dx\,dz\int_l \frac{1}{2}(1-\xi)\ast\frac{1}{2}(1-\xi)\,d\xi.$$

Scanned by CamScanner

$\rightarrow + C_{26} \int_A 2.5(1-\beta) \times 2.5(1-\beta)\, dx\, dz \int_l \frac{1}{2}(1-\xi) \times \frac{1}{2}(1-\xi)\, d\xi$

$+ C_{44} \int_A \frac{1}{4}(1-\alpha)(1-\beta) \times \frac{1}{4}(1-\alpha)(1-\beta)\, dx\, dz$

$\times \int_l -\frac{1}{2} \times -\frac{1}{2}\, d\xi$

$\left[\because N_{1,y} = -\frac{1}{2} \right]$

~~β has~~

α and β has 4 values in gauss quadrature

my code: (First component of K_xx)

K_xx = C22 * np.sum (w_cs * F1,x * F1,x * J_cs)

* np.sum (w_length * shapefunc[1] * shapefunc[1] * J_length).

since α and β has 4 values $F_{1,x}$ ~~and F~~ will have four values. therefore $F_{1,x}$ will be an array.

$$np.sum \left[\begin{bmatrix} w_{Length} \end{bmatrix} * \begin{bmatrix} F_{1,x} \end{bmatrix} * \begin{bmatrix} F_{1,x} \end{bmatrix} * \begin{bmatrix} J\_C_s \end{bmatrix} \right]$$

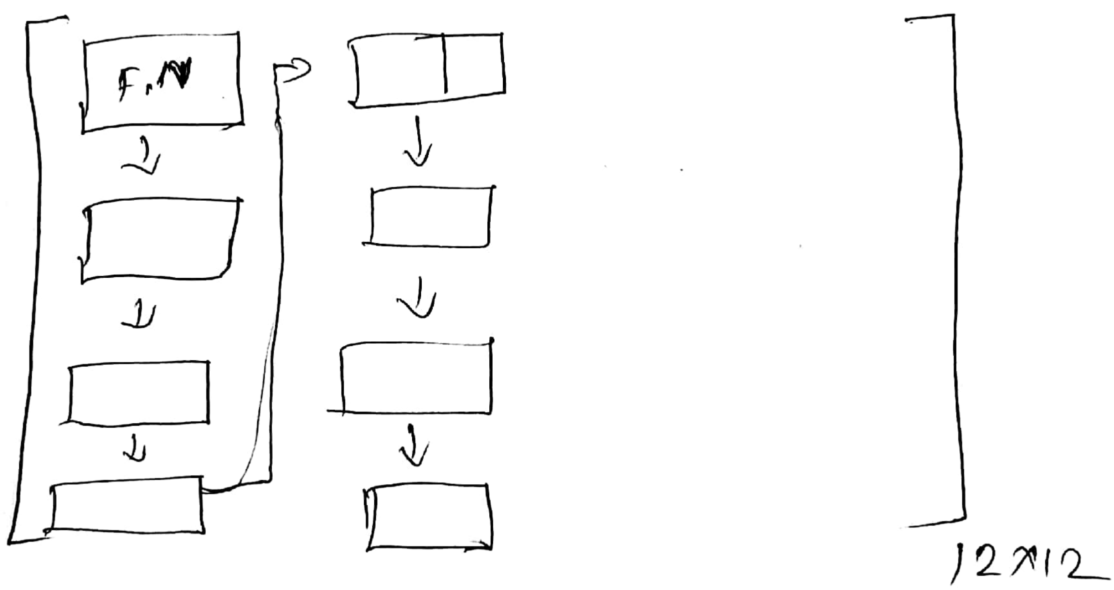
So my code will multiply corresponding element of each column and add all of them (ie first element of each column and the second element of each column so on)

wlength[1] * $F_{1,x}$[1] * $F_{1,x}$ [1] * J_cs[1]

Scanned by CamScanner

10) After that the ~~Compont~~ components (k_xx....) are then stacked in 3×3 array to form a fundamental nuclei

11) then the Fundamental nuclei is stacked into the Nodal stiffness matrix.



Scanned by CamScanner