Master on Numerical Methods in Engineering

Computational Structural Mechanics and Dynamics

Assignment 9

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Assignment

a) Describe in extension how can be applied a non symmetric load on this formulation.
b) Using thin beams formulation, describe the shape of the $B^{(e)}$ matrix and comment the integration rule.

(MOC)

Using thin beams formulation, describe the shape of the $B^{(e)}$ matrix and comment the integration rule.

Euler Bernoulli theory for thin beams, or its equivalent in 2D, the Kirchhoff Plate Theory, do not consider the shear stresses from the structure. This simplification is applied when thickness is too small. In beams it implies that the transverse cross-section remain plane and orthogonal to the beam axis after deformation. In the shells structures, it implies that the normal to the generatrix remains straight and orthogonal after deformation.

From the three strains that can occur:

- membrane strain (m)
- bending strain (b)
- ~~transverse shear strain~~ (s)

Transverse shear strain is rejected.

Local generalized strains remain as follow:

$$\varepsilon = \begin{Bmatrix} \frac{\partial u'}{\partial s} - \frac{w'_0}{R} \\ \frac{u'_0 \cos\phi - w'_0 \operatorname{sen}\phi}{x} \\ \hline 0 \end{Bmatrix} + \begin{Bmatrix} -z' \frac{\partial \theta}{\partial s} \\ -z \theta \frac{\cos\theta}{x} \\ \hline \frac{\partial w'_0}{\partial s} + \frac{w_0}{R} - \theta \end{Bmatrix} = \begin{Bmatrix} \hat{\varepsilon}'_m \\ 0 \end{Bmatrix} + \begin{Bmatrix} \hat{z}'\hat{\varepsilon}_b \\ \hat{\varepsilon}'_s \end{Bmatrix}$$

$B^{(e)}$ matrix will result as: $B^{(e)} = \begin{Bmatrix} B_b^{(e)} \\ B_m^{(e)} \end{Bmatrix}$.

Related to the Gaussian Integration:

For the shell analysis only shear stiffness matrix requires Gauss Points to be evaluated.