Universitat Politècnica de Catalunya
Numerical Methods in Engineering
Computational Structural Mechanics and Dynamics

Axisymmetric shells

Assignment 9

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1 Assignment 9.1

Describe in extension how a non symmetric load can be applied on this formulation.

The solution to this is using Fourier series. Whe discretize the force into a fourier sum as such:

$$f(\theta) = \frac{a_0}{2} + \sum_{n=1}^{m} \left(a_n \cos(n\theta) + b_n \sin(n\theta)\right) \tag{1}$$

and solve the analysis for each harmonic. The advantage of the Fourier series is that the force is decomposed into a set of symmetric and antisymmetric modes, which makes the analysis simpler than simply working with any arbitrary load distribution. The solution will be given as a sum of harmonic displacement fields as well. To do this we must implement a formulation that uses a_i and b_i as the unknowns. This will be more expensive than the model for axisymmetrical loads, but still cheaper that a full 3D analysis.

2 Assignment 9.2

Using thin beams formulation, describe the shape of the $B^{(e)}$ matrix and comment the integration rule.
Since we are considering thin shells, we can do away with the transverse shear. Then the matrix B becomes smaller:

$$B^e = \begin{bmatrix} B_m^e \\ B_b^e \end{bmatrix} \tag{2}$$

The integration rule we use will, amongst other things, determine the accuracy of our solution. It is important, however, to use a quadrature that does not require the value of function at either end of the element, since some nodes can be on the symmetry axis where all divisions by r will become unbounded. Gauss quadrature, for instance, is a good candidate, because it never uses the values at $\xi = \pm 1$ nor $\eta = \pm 1$.